12. NEEDS OF FARMERS AND WOMEN

12.1 Farmers' Needs

Interviews with 108 farmers in the model areas were carried out to know about their needs for acceleration of the socio-economic activities in rural areas. In such interviews, each farmer was requested to choose three main items with the first, second and third priority that he considers important for generating more income and food through his socio-economic activities. The results of the interviews are summarized in the following table:

(Unit: Count)

	Item	Xai	Beng	Hun	Total
1.	Irrigation development	95	100	98	293
2.	Agricultural development	51	48	30	129
3.	Land development	15	20	36	71
4.	Livestock raising	15	10	9	34
5.	Electricity supply	18	14	2	34
6.	Drinking water supply	4	8	13	25
7.	Road development	0	0	18	18
8.	Forest and soil conservation	1	12	4	17
9.	School (education)	10	1	5	16
10.	Health and clinic	4	0	1	5
11.	Cottage industry	0	0	0	0

Note: The above figures were obtained, multiplying the original number of each item by weight factors of 3, 2 and 1 for first, second and third priority, respectively.

As seen in the above table, the farmers give a top priority to the development of productive infrastructures such as irrigation and land rather than social infrastructures.

12.2 Women's Needs

Interviews with 50 families including both husband and wife in the model areas were carried out to catch their needs separately. The results of interviews are summarized in the following table:

(Unit: Count)

	Item	Total	Male	Female
1.	Irrigation development	117	61	56
2.	Agricultural development	117	60	57
3.	Electricity Supply	84	45	39
4.	Rice mill	43	12	31
5.	School (education)	42	26	16
6.	Drinking water supply	38	15	23
7.	Road development	35	23	12
8.	Health and clinic	34	10	24
9.	Livestock raising	28	14	14
10.	Credit	9	9	0
11.	Handicraft development	7	3	4

Note: The above figures were obtained, multiplying the original number of each item by weight factors of 3, 2 and 1 for the first, second and third priority, respectively.

There is the similarity of felt needs between male and female, but it should be noted that the women give relatively high priority to rice mill, health and clinic, and drinking water supply.

Table

Table FB-1 Population and Number of Families

		Ethnic Group	Type of Village	No. of Family	Total Population
Xai	Done Xai*	LT	new	31	168
	Na Kang	LL	new	17	100
	Thin	LL	old	166	959
	Cheng	LL	old	132	832
	Na Lao	LL	old	135	894
	Na Mi	Mix	old	38	230
	Na Lee	LL	old	58	356
	Na Sao	LL	old	57	337
	Houay Khum	Mix	old	97	480
	Total			731	4,356
Beng	Pang Dua	LL	old	62	365
	Pho Keo	LL	old	74	477
	Beng Kham	LL	old	79	393
	Na Houay	LL	old	57	340
	Beng Louang	LL	old	93	502
	Takhat	LL	old	84	532
	Houay La*	LT	new	59	406
	Total			508	3,015
Hun	Mai	LT	new	54	262
	Na	LT	new	118	657
	Som Xai	LT	new	176	872
	Somphon	LT	new	126	641
	Nakham Nua	Mix	new	50	261
	Nakham Tai	LL	old	60	351
	Phonsavat	LL	old	85	491
	Total			669	3,535

None: LL = Lao Loum LT = Lao Theung
Type of village,
Old: Villagers settled in or near present place before 1970
New: Villagers settled in or near present place after 1970
*: The villages are indirectly related to the model areas.

Data Source: District Offices

Table FB-2 Area of Rice Cultivation and Holding Size

		Ethnic Group	Type of Village	Lowland Rice Field (ha)		Upland Rice Field (ha)	
				Total	Per Family	Total	Per Family
Xai	Done Xai*	LT	new	8.0	0.26	5.0	0.16
	Na Kang	LL	new	5.0	0.29	0.0	0.0
	Thin	LL	old	101.6	0.61	0.0	0.0
	Cheng	LL	old	75.2	0.57	2.8	0.02
	Na Lao	LL	old	34.7	0.26	0.0	0.0
	Na Mi	Mix	old	25.3	0.67	24.1	0.63
	Na Lee	LL	old	54.2	0.93	0.0	0.0
	Na Sao	LL	old	54.1	0.95	2.2	0.04
	Houay Khum	Mix	old	31.4	0.32	18.0	0.19
	Total/Average			389.5	0.53	52.1	0.07
Beng	Pang Dua	LL	old	20.4	0.33	36.3	0.59
	Pho Keo	LL	old	37.3	0.50	5.0	0.07
	Beng Kham	LL	old	45.2	0.57	1.0	0.01
	Na Houay	LL	old	39.1	0.67	21.0	0.37
	Beng Louang	LL	old	64.7	0.70	1.4	0.02
	Takhat	LL	old	41.3	0.49	21.2	0.25
	Houay La*	LT	new	4.4	0.07	53.5	0.91
	Total/Average			252.4	0.50	139.4	0.27
Hun	Mai	LT	new	7.0	0.13	44.4	0.82
	Na	LT	new	34.0	0.29	71.0	0.60
	Som Xai	LT	new	36.4	0.21	163.0	0.93
	Somphon	LT	new	9.3	0.07	140.0	1.11
	Nakham Nua	Mix	new	19.0	0.38	26.3	0.53
	Nakham Tai	LL	old	53.5	0.89	10.9	0.18
	Phonsavat	LL	old	49.0	0.58	29.7	0.35
	Total/Average			208.2	0.31	485.3	0.73

None: LL = Lao Loum LT = Lao Theung
Type of village,
Old: Villagers settled in or near present place before 1970
New: Villagers settled in or near present place after 1970
*: The villages are indirectly related to the model areas.
Data Source: District Offices

Table FB-3 Ethnic and Religion of the Interviewees

(Unit: Number)

	Lao Loum	Lao Theung	Buddist	Animist
Xai				
Done Xai		10		10
Na Kang	10		1	9
Thin	10		10	
Cheng	6		6	
Na Lao	6		6	
Na Mi	3	3	6	
Na Lee	6		6	
Na Sao	6		6	
Houay Khum	4	2	5	1
Beng				
Pang Dua	6		6	
Pho Keo	6		6	
Beng Kham	5	1	5	1
Na Houay	6		6	
Beng Louang	6		6	
Takhat	6		6	
Houay La		10		10
Hun				
Mai		6		6
Na		6		6
Som Xai		6	1	5
Somphon		6		6
Nakham Nua	2	4	2	4
Nakham Tai	6		6	
Phonsava	10		10	
Total	104	54	100	58

Table FB-4 Population Structure

(Unit: Number)

	Age Group		0-15	16-30	31-45	46-60	61-	TOTAL	No. of sample family
Xai									
	Done Xai	LT	29	12	7	8	5	61	10
	Na Kang	LL	41	21	7	10	4	83	10
	Thin	LL	31	23	9	8	5	76	10
	Cheng	LL	19	11	8	2	6	46	6
	Na Lao	LL	16	8	2	5	4	35	6
	Na Mi	Mix	24	8	7	3	1	43	6
	Na Lee	LL	21	17	4	7	2	51	6
	Na Sao	LL	15	7	6	7	1	36	6
	Houay Khum	Mix	29	8	6	5	3	51	6
	Sub-total		225	115	56	55	31	482	
	PC (%)		47	24	12	11	6	100	
Beng									
	Pang Dua	LL	25	7	9	3	0	44	6
	Pho Keo	LL	26	7	8	4	1	46	6
	Beng Kham	LL	22	6	10	4	1	43	6
	Na Houay	LL	24	13	5	6	2	50	6
	Beng Louang	LL	23	18	3	10	4	58	6
	Takhat	LL	23	18	2	9	2	54	6
	Houay La	LT	40	30	18	9	5	102	10
	Sub-total		183	99	55	45	15	397	
	PC (%)		46	25	14	11	4	100	
Hun									
	Mai	LT	17	10	4	2	0	33	6
	Na	LT	19	15	5	6	3	48	6
	Som Xai	LT	11	11	5	6	2	35	6
	Somphon	LT	18	4	9	0	1	32	6
	Nakham Nua	Mix	17	11	5	4	3	40	6
	Nakham Tai	LL	22	9	7	3	2	43	6
	Phonsavat	LL	33	19	11	5	4	72	10
	Sub-total		137	79	46	26	15	303	
	PC (%)		45	26	15	9	5	100	
	Total		545	293	157	126	61	1,182	
	PC (%)		46	25	13	11	5	100	

Note: LL = Lao Loum, LT = Lao Theung, Mix = Ethnic Mixed
PC = Population composition

Table FB-5 Family Labor Force

(Unit: number)

	Ethnic	Population	Work force	Farm Worker	No. of Sampled family	Person per family	work force per family	farm worker per family
Xai								
Done Xai	LT	61	32	30	10	6.1	3.2	3.0
Na Kang	LL	83	38	38	10	8.3	3.8	3.8
Thin	LL	76	36	27	10	7.6	3.6	2.7
Cheng	LL	46	26	16	6	7.7	4.3	2.7
Na Lao	LL	35	17	13	6	5.8	2.8	2.2
Na Mi	Mix	43	21	15	6	7.2	3.5	2.5
Na Lee	LL	51	24	22	6	8.5	4.0	3.7
Na Sao	LL	36	21	17	6	6.0	3.5	2.8
Houay Khum	Mix	51	13	11	6	8.5	2.2	1.8
Total/Average		482	228	189	66	7.3	3.4	2.8
Beng								
Pang Dua	LL	44	14	14	6	7.3	2.3	2.3
Pho Keo	LL	46	19	19	6	7.7	3.2	3.2
Beng Kham	LL	43	20	19	6	7.2	3.3	3.2
Na Houay	LL	50	14	13	6	8.3	2.3	2.2
Beng Louang	LL	58	23	17	6	9.7	3.8	2.8
Takhat	LL	54	25	22	6	9.0	4.2	3.7
Houay La	LT	102	51	45	10	10.2	5.1	4.5
Total/Average		397	166	147	46	8.6	3.6	3.2
Hun								
Mai	LT	33	14	14	6	5.5	2.3	2.3
Na	LT	48	22	21	6	8.0	3.7	3.5
Som Xai	LT	35	19	18	6	5.8	3.2	3.0
Somphon	LT	32	14	14	6	5.3	2.3	2.3
Nakham Nua	Mix	40	21	20	6	6.7	3.5	3.3
Nakham Tai	LL	43	21	19	6	7.2	3.5	3.2
Phonsavat	LL	72	32	22	10	6.6	3.2	2.2
Total/Average		303	143	128	46	6.6	3.1	2.8

Table FB-6 Population in the Model Areas

	Ethnic	No. of Sample family	Population			Person per family	Type of village*
			Total	Male	female		
Xai							
Done Xai	LT	10	61	27	34	6.1	new
Na Kang	LL	10	83	39	44	8.3	new
Thin	LL	10	76	35	41	7.6	old
Cheng	LL	6	46	24	22	7.7	old
Na Lao	LL	6	35	15	20	5.8	old
Na Mi	Mix	6	43	21	22	7.2	old
Na Lee	LL	6	51	26	25	8.5	old
Na Sao	LL	6	36	19	17	6.0	old
Houay Khum	Mix	6	51	24	27	8.5	old
Average						7.3	
Beng							
Pang Dua	LL	6	44	22	22	7.3	old
Pho Keo	LL	6	46	25	21	7.7	old
Beng Kham	LL	6	43	22	21	7.2	old
Na Houay	LL	6	50	25	25	8.3	old
Beng Louang	LL	6	58	34	24	9.7	old
Takhat	LL	6	54	27	27	9.0	old
Houay La	LT	10	102	47	55	10.2	new
Average						8.6	
Hun							
Mai	LT	6	33	17	14	5.5	new
Na	LT	6	48	24	24	8.0	new
Som Xai	LT	6	35	18	17	5.8	new
Somphon	LT	6	32	14	18	5.3	new
Nakham Nua	Mix	6	40	20	20	6.7	new
Nakham Tai	LL	6	43	20	23	7.2	old
Phonsavat	LL	10	72	26	46	6.6	old
Average						6.6	

* old: villagers settled in or near present place before 1970
new: villagers settled in or near present place after 1970

Table FB-7 Livestock Holding Size

(Unit: Number/family)

			Buffalo	Cattle	Pig	Poultry
Xai						
	Done Xai	LT	0.3	0.6	0.3	4.9
	Na Kang	LL	1.6	0.7	2.7	10.9
	Thin	LL	2.3	0.8	0.3	18.8
	Cheng	LL	4.0	3.3	2.5	8.3
	Na Lao	LL	2.5	0.7	2.7	13.2
	Na Mi	Mix	1.0	0.5	0.5	32.5
	Na Lee	LL	2.0	3.3	0.7	14.5
	Na Sao	LL	3.0	4.7	1.7	22.2
	Houay Khum	Mix	2.2	2.3	0.3	7.2
	Average		2.1	1.9	1.3	14.7
Beng						
	Pang Dua	LL	1.8	1.8	2.0	22.5
	Pho Keo	LL	4.5	7.5	3.0	31.2
	Beng Kham	LL	2.0	3.7	2.7	15.3
	Na Houay	LL	2.7	4.2	3.7	14.7
	Beng Louang	LL	4.3	3.7	5.8	44.2
	Takhat	LL	8.2	0.5	2.5	13.8
	Houay La	LT	2.6	0.4	2.3	1.1
	Average		3.7	3.1	3.1	21.8
Hun						
	Mai	LT	1.9	0.0	0.5	8.0
	Na	LT	3.0	0.3	2.5	17.8
	Som Xai	LT	3.7	0.0	1.2	3.8
	Somphon	LT	2.0	0.2	0.2	4.5
	Nakham Nua	Mix	2.7	0.5	2.0	15.8
	Nakham Tai	LL	4.3	0.8	5.8	19.2
	Phonsavat	LL	2.8	0.9	1.7	8.3
	Average		2.9	0.4	2.0	11.1

Table FB-8 Holding and Sold Number of Livestock

(Unit: number)

		Buffalo		Cattle		Pig		Poultry	
		a	b	a	b	a	b	a	b
Xai									
Done Xai	LT	3	2	6	0	8	5	49	20
Na Kang	LL	16	1	7	0	29	0	109	0
Thin	LL	23	3	8	0	12	9	188	77
Cheng	LL	24	0	20	0	15	2	50	0
Na Lao	LL	15	0	4	3	16	16	79	12
Na Mi	Mix	6	1	3	0	3	0	195	0
Na Lee	LL	12	2	20	1	12	8	87	0
Na Sao	LL	18	0	28	4	34	24	133	112
Houay Khum	Mix	13	0	14	1	6	4	43	0
Sub-total		130	9	110	9	135	68	933	221
Sold livestock (%)			7		8		50		24
Beng									
Pang Dua	LL	11	3	11	0	12	6	135	24
Pho Keo	LL	27	0	45	3	18	5	187	3
Beng Kham	LL	12	1	22	2	16	10	92	0
Na Houay	LL	16	0	25	7	22	3	88	5
Beng Louang	LL	26	7	22	2	35	8	265	30
Takhat	LL	49	1	3	3	15	15	83	4
Houay La	LT	26	2	5	1	23	21	111	20
Sub-total		167	14	133	18	141	68	961	86
Sold livestock (%)			8		13		48		9
Hun									
Mai	LT	11	0	0	0	3	0	48	4
Na	LT	18	2	2	0	15	9	107	47
Som Xai	LT	22	4	0	0	7	0	22	0
Somphon	LT	12	1	1	0	1	0	27	0
Nakham Nua	Mix	16	0	3	0	12	0	95	3
Nakham Tai	LL	26	1	5	4	35	3	115	0
Phonsavat	LL	28	1	9	1	48	31	83	45
Sub-total		133	9	20	5	121	43	497	99
Sold livestock (%)			7		25		36		20

Note: a = number of holding livestock
b = number of sold livestock

Table FB-9 Slash-and-burn Cultivation

(unit: number)

	Doing the cultivation?		Sufficient forest for the cultivation?		Intention of the cultivation			Condition of discontinuation		
	YES	NO	YES	NO	stop	Continue	Start	Irriga-tion	Land clearing	Others
Xai										
Done Xai	3	7			2	1	-	2	-	1
Na Kang	-	10			-	-	-	-	-	-
Thin	-	10			-	-	-	-	-	-
Cheng	-	6	-	6	3	-	1	-	-	-
Na Lao	-	6	-	6	2	-	1	-	-	-
Na Mi	1	5	1	4	3	-	-	1	1	-
Na Lee	-	6	-	6	5	-	-	-	-	-
Na Sao	-	6	2	4	2	-	-	-	-	-
Houay Khum	1	5	2	3	1	-	-	1	1	-
Beng										
Pang Dua	6	-	-	6	6	1	-	5	5	2
Pho Keo	3	3	-	6	6	-	-	6	4	-
Beng Kham	-	6	-	2	1	-	-	-	-	-
Na Houay	5	1	4	5	6	-	-	6	5	1
Beng Louang	3	2	-	4	5	-	-	6	4	2
Takhat	3	3	-		3	-	-	3	3	1
Houay La	10	-			5	5	-	9	10	3
Hun										
Mai	6	-	-	6	2	-	-	6	6	-
Na	6	-	-	5	5	1	-	6	6	-
Som Xai	6	-	1	5	4	1	-	6	6	-
Somphon	6	-	1	6	3	-	-	5	6	1
Nakham Nua	6	-	-	5	6	-	-	5	5	1
Nakham Tai	1	5	-		1	-	-	3	2	3
Phonsavat	6	4			4	2	-	5	4	-

Table FB-10 Frequency of Hunting, Fishing and Collecting

(unit: %)

			Hunting			Fishing			Collecting		
Xai			<1>	<2>	<3>	<1>	<2>	<3>	<1>	<2>	<3>
	Done Xai	LT	10	30	60	-	10	90	60	40	-
	Na Kang	LL	-	10	90	10	-	90	-	20	80
	Thin	LL	-	20	80	10	70	20	40	20	40
	Cheng	LL	-	-	100	-	50	50	33	-	66
	Na Lao	LL	-	33	66	-	83	17	33	-	17
	Na Mi	Mix	17	-	83	-	66	33	80	20	-
	Na Lee	LL	-	60	40	-	66	33	83	17	-
	Na Sao	LL	-	17	83	17	66	17	83	17	-
	Houay Khum	Mix	-	33	66	17	83	-	83	17	-
	Average		3	23	74	6	55	39	60	17	23
Beng											
	Pang Dua	LL	17	50	33	60	40	-	80	20	-
	Pho Keo	LL	20	60	20	33	66	-	100	-	-
	Beng Kham	LL	-	33	66	100	-	-	100	-	-
	Na Houay	LL	-	33	66	50	50	-	100	-	-
	Beng Louang	LL	-	-	100	-	33	66	-	100	-
	Takhat	LL	-	66	33	33	50	17	83	-	17
	Houay La	LT	10	60	30	-	60	40	70	30	-
	Average		7	43	50	40	42	18	76	21	3
Hun											
	Mai	LT	17	50	33	33	50	17	83	17	-
	Na	LT	-	83	17	17	83	-	50	50	-
	Som Xai	LT	-	66	33	-	50	50	60	-	40
	Somphon	LT	17	50	33	25	25	50	50	50	-
	Nakham Nua	Mix	-	80	20	-	75	25	60	40	-
	Nakham Tai	LL	-	25	75	50	33	17	60	40	-
	Phonsavat	LL	-	40	60	-	90	10	20	70	10
	Average		5	56	39	18	58	24	55	38	7

(1): quite often, (2): sometimes, (3): never

Table FB-11 Hired Labor and Labor Exchange

(unit: number)

	Hired in		Hired out		Labor exchange preference		
	YES	NO	YES	NO	Relative	Neighbor	Both
Xai							
Done Xai		10		10	4	6	
Na Kang	1	9	1	9	1	9	
Thin		10	2	8	2	8	
Cheng	1	3		6	2		3
Na Lao		2		6	1		3
Na Mi		4		5	2		3
Na Lee		6	1	5	4		2
Na Sao		3		6	2	1	3
Houay Khum		3		6	3		2
Beng							
Pang Dua		6		6	1	1	4
Pho Keo	2	3		4		1	3
Beng Kham		6		6	1		5
Na Houay	4	1	1	4	4		
Beng Louang	1	3	2	2	4		2
Takhat	1	5		6	1		5
Houay La	1	9	1	9	3	7	
Hun							
Mai		6		6	4		2
Na	1	5		6	4		2
Som Xai		6		6	1		5
Somphon		6		6	3		3
Nakham Nua		6		6	3	1	2
Nakham Tai		6		6	3	1	2
Phonsavat	3	7	1	9	5	5	
Total	15	125	9	143	58	40	51

Table FB-12 Items of Labor Exchange

(Unit: count)

	Ethnic group	Planting	Weeding	Land clearing	Thresh-ing	Harvest-ing	Fencing	Trans-portation
Xai								
Cheng	LL	5	-	-	5	5	-	5
Na Lao	LL	3	-	1	3	3	-	2
Na Mi	Mix	5	-	1	5	5	-	3
Na Lee	LL	6	-	-	6	6	-	5
Na Sao	LL	6	-	-	6	6	-	5
Houay Khum	Mix	5	1	-	5	5	-	5
Total	LL	30	1	2	30	30	-	25
Beng								
Pang Dua	LL	5	2	-	5	6	-	3
Pho Keo	LL	6	-	-	6	6	-	5
Beng Kham	LL	6	-	-	6	6	-	6
Na Houay	LL	3	-	-	2	3	-	1
Beng Louang	LL	6	-	-	6	6	-	6
Takhat	LL	6	3	3	6	6	3	5
Total		32	5	3	31	33	3	26
Hun								
Mai	LT	5	5	-	5	5	2	6
Na	LT	6	4	2	6	6	2	5
Som Xai	LT	6	4	-	6	6	2	6
Somphon	LT	3	6	-	4	6	1	4
Nakham Nua	Mix	5	3	1	4	5	1	5
Nakham Tai	LL	6	1	-	5	6	-	6
Total		31	23	3	30	34	8	32

LL: Lao Loum
LT: Lao Theung

Table FB-13 Division of Labor

		Lao Loum				Lao Theung			
		H	W	MC	FC	H	W	MC	FC
1)	Cooking		◎		○	○	◎		○
	Child care	○	◎		○	○	◎		
	Water Fetching		◎	○	◎		◎		○
	Collecting firewood	○	◎	○	◎		◎		○
	Handicarft	○	○			◎			
	Marketing		◎		○	◎	○		○
	Home garden	◎	◎	○	○	◎	○		○
	House building	◎	○			◎	○		
	Land clearing	◎		◎		◎	○		
	Milling rice		◎		◎		◎		○
2)	Hunting	○				◎		○	
	Fishing	◎	○	○	○	○	◎	○	○
	Collecting	○	◎		◎	○	◎		○
3)	Livestock care								
	Buffalo	◎		◎		◎		○	
	Cattle	○		○		◎		○	
	Pig	○	◎		◎		◎		○
	Poultry		◎		○		◎		○
4)	Paddy cultivation								
	Land preparation	◎		○					
	Sowing	◎	○	○					
	Transplanting		◎		◎				
	Weeding*	○		○					
	Harvesting	◎	◎	○	○				
	Transporting	◎	◎	○	○				
	Threshing	◎	◎	○	○				
5)	Slash and burn cultivation								
	Slashing					◎	◎	○	○
	Burning					◎	○		
	Fencing					◎	○		
	Dibbing					◎			
	Sowing						◎	○	○
	Weeding					◎	◎	○	○
	Harvesting & threashing					◎	◎	○	○
	Transporting					◎	◎	○	○

Note: H: Husband
W: Wife
MC: Male children
FC: Female children

◎: Mainly responsible
○: Helper

*: in the case of footpath between rice fields

Table FB-14 Water Sources for Domestic Use

(Unit:count, plural answer)

	River	Well	Pipe Water	Rain
Xai				
Done Xai		10		
Na Kang	7	4		
Thin	3		7	
Cheng			6	
Na Lao			6	
Na Mi	4	2	2	1
Na Lee	6	1		1
Na Sao	6			1
Houay Khum	5	2		2
Total	31	19	21	5
Beng				
Pang Dua	6			
Pho Keo	1	5		1
Beng Kham		1	5	
Na Houay	2		5	
Beng Louang			6	
Takhat	1	2	6	
Houay La		5	10	
Total	10	13	32	1
Hun				
Mai	6	1		
Na	6			2
Som Xai	3	1	2	
Somphon	4	1	1	1
Nakham Nua	4	1	1	1
Nakham Tai	6			
Phonsavat	4	6		
Total	33	10	4	4

Table FB-15 Farmers' View on Their Strata

		Consciousness of social strata (%)		
		Rich	Middle	Poor
Xai				
Done Xai	LT	-	30	70
Na Kang	LL	10	70	20
Thin	LL	-	70	30
Cheng	LL	33	67	-
Na Lao	LL	-	83	17
Na Mi	Mix	-	33	67
Na Lee	LL	-	100	-
Na Sao	LL	-	100	-
Houay Khum	Mix	-	100	-
Average		5	72	23
Beng				
Pang Dua	LL	17	50	33
Pho Keo	LL	17	50	33
Beng Kham	LL	-	83	17
Na Houay	LL	33	50	17
Beng Louang	LL	33	33	33
Takhat	LL	17	66	17
Houay La	LT	30	40	30
Average		21	53	26
Hun				
Mai	LT	-	17	83
Na	LT	17	66	17
Som Xai	LT	-	50	50
Somphon	LT	-	33	67
Nakham Nua	Mix	-	100	-
Nakham Tai	LL	17	83	-
Phonsavat	LL	10	70	20
Average		6	60	34

Table FB-16 Balance of Expenditure and Income

			Balance of Expenditure and Income (%)		
			E>I	E=I	E<I
Xai					
	Done Xai	LT	50	50	-
	Na Kang	LL	80	20	-
	Thin	LL	20	50	30
	Cheng	LL	50	17	33
	Na Lao	LL	60	-	40
	Na Mi	Mix	100	-	-
	Na Lee	LL	-	50	50
	Na Sao	LL	83	-	17
	Houay Khum	Mix	50	50	-
	Average		55	26	19
Beng					
	Pang Dua	LL	67	33	-
	Pho Keo	LL	-	67	33
	Beng Kham	LL	-	100	-
	Na Houay	LL	50	-	50
	Beng Louang	LL	-	67	33
	Takhat	LL	17	50	33
	Houay La	LT	50	30	20
	Average		26	50	24
Hun					
	Mai	LT	67	33	-
	Na	LT	66	17	17
	Som Xai	LT	83	17	-
	Somphon	LT	33	67	-
	Nakham Nua	Mix	67	33	-
	Nakham Tai	LL	50	50	-
	Phonsavat	LL	20	40	40
	Average		55	37	8

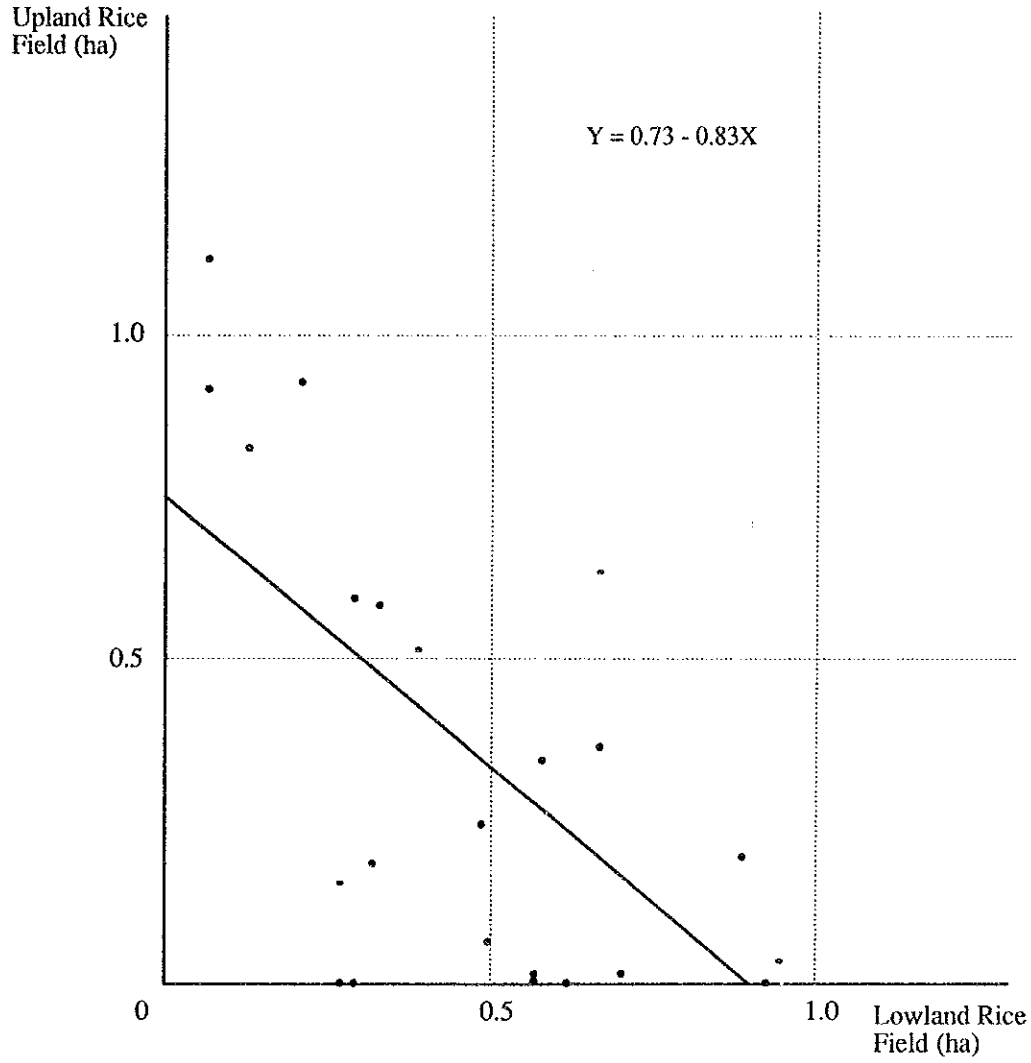
Table FB-17 Family Expenditure

(Unit: Kip 1,000)

		Clothes	Foods	Health	Educa-tion	Transpor-tation	Taxes	Others	Total
Xai									
Na Lao	LL	53	87	44	6	5	6	59	260
Na Sao	LL	40	113	35	18	8	11	45	270
Na Lee	LL	83	153	36	11	66	13	51	413
Lao Loum average		59	118	38	12	26	10	52	315
Na Mi	Mix	53	102	47	11	14	8	50	285
Houay Khum	Mix	54	118	18	7	14	5	90	306
Mix village average		54	110	33	9	14	7	70	297
Beng									
Pang Dua	LL	22	91	11	3	5	5	27	164
Pho Keo	LL	60	113	50	6	32	5	73	339
Beng Kham	LL	51	57	27	4	12	12	23	186
Na Houay	LL	40	75	30	23	31	6	43	248
Beng Louang	LL	63	39	65	59	19	18	69	332
Takhat	LL	58	117	33	21	32	8	43	312
Lao Loum average		49	82	36	19	22	9	46	263
Hun									
Mai	LT	13	19	15	2	4	3	10	66
Na	LT	38	60	31	11	11	9	29	189
Som Xai	LT	40	35	34	11	6	8	14	148
Somphon	LT	24	19	16	1	5	6	7	78
Lao Theung average		29	33	24	6	6.5	6.5	15	120
Nakham Tai	LL	43	53	26	9	14	11	26	182
Nakham Nua	Mix	31	50	28	6	10	7	26	158

Note: * Others include farm inputs, ceremonies, hired labour, and so forth.

Figure



Note: This figure is prepared on the basis of Table FB-2
(Lowland and Upland Rice Field per Family)

Fig. FB-1 Relationship of Average Size between Upland and Lowland Fields

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
AGRICULTURAL DEVELOPMENT PROJECT TO CONTROL SLASH AND BURN CULTIVATION IN OUDOMXAY PROVINCE
NIPPON KOEI CO., LTD. CONSTRUCTION PROJECT CONSULTANTS, INC.

ANNEX-FC
AGRICULTURE

ANNEX-FC AGRICULTURE

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1. INTRODUCTION

This ANNEX-FC presents the result of feasibility study on the agricultural development plan in the model areas which forms part of the integrated rural agricultural development in the model areas proposed for implementation in the short term development phase formulated under the Master Plan.

The proposed plan is consisting of agricultural development plan in the model areas scheme which is proposed in the Master Plan for short term development phases.

The proposed agricultural development plan is for short term development phase and concentrated to increase in lowland rice production with irrigation development in the areas. The lowland rice cultivation has been widely applied in the areas, and the practical level of farmers for further improvement of farming technique has been established already.

In line with the agricultural development strategy to increase and stabilize food production at first and based on both local socio-economic and natural conditions in and around the model areas, the study on the proposed agricultural development is made under the Feasibility Study on the Agricultural Development in the Model Areas, as presented in this ANNEX-FC.

2. GENERAL CONDITION

2.1 Climate

The climatic conditions in the three model areas have no considerable differences each other. Climatic condition important for agriculture are examined based on data obtained through Oudomxay meteorological station. Mean annual rainfall is 1,200 to 1,300 mm, and 81 to 84% of annual rainfall in monsoon season from May to September. Mean annual temperature is 23.5°C, which is cooler than those in Vientiane and Luang Prabang. Highest temperature of 36-38°C occurs in April or May (see ANNEX-MA). The period from December to February is cool, and the lowest of 4-6°C occurs during this period. Mean monthly annual rainfall, maximum, minimum temperatures, and mean monthly sunshine hour are as follows:

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
R	5.4	39.5	39.7	78.6	152.4	190.5	291.5	239.4	108.4	54.7	17.4	3.1
T	26.5	28.7	30.9	32.9	31.9	30.0	29.6	29.9	30.1	29.0	26.6	24.4
t	10.4	10.2	13.7	17.0	20.5	22.1	22.1	21.7	21.0	18.9	14.9	9.6

Note: R; rainfall (mm), T; mean maximum temperature (°C), t; mean minimum temperature (°C).

Sunshine Hour

(Unit: hr/day)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1989	-	-	-	-	5.9	3.4	4.2	5.2	4.4	4.9	-	5.9	-
1990	4.5	5.3	5.2	5.6	3.4	1.0	1.3	4.6	3.4	3.1	4.2	5.4	3.9
1991	5.9	6.1	4.8	5.3	7.3	2.0	2.1	2.7	4.6	5.3	4.2	4.0	4.5
1992	4.5	6.1	6.9	6.3	7.3	4.1	3.5	5.2	5.6	3.7	5.1	-	-
Average	5.0	5.8	5.6	5.7	6.0	2.6	2.8	4.4	4.5	4.3	4.5	5.1	4.7

2.2 Soil

The soils of the model areas are broadly classified into three units: alluvial fans, lower terraces, and steeply dissected mountains. The alluvial fans are developed along the main rivers. The soils are deep and have good physical conditions with sandy loam to clay in soil textual class. The lower terraces are located on the foot of hills, just in slightly higher position than the alluvial fans, and have moderately soil depth with well internal drainage.

A general recommendation for effective use of soils in the model areas is the need of deep plowing and incorporation of organic matter to the soil for improving the physical conditions and fertility of soils. Chemical fertilizers, mainly nitrogen, are required for high-yielding crop varieties.

Population of 16-60 age group is categorized as the labour force, and approximately 47, 42 and 47% of the total population in Xai, Beng and Hun model areas are in this group, respectively. Out of this, about 83% is engaged in agriculture in Xai model area, 90% in Beng and Hun areas. The average working days are assumed at 70% of a year, and the farm labour force is roughly estimated as follows:

(Unit: person)

	Population	Total Labour Force	Agricultural Labour Force	Available No. of Agri. Labour
Xai	4,356	2,047	1,669	1,168
Beng	3,015	1,266	1,139	797
Hun	3,535	1,661	1,495	1,045

The total available number of agricultural labour a day is estimated at about 1,140, 850 and 1,000 in Xai, Beng and Hun model areas, respectively.

3. AGRICULTURAL CONDITION

3.1 Crop Yield

3.1.1 Result of Rice Yield Survey

In order to collect data on the present yield level of lowland and upland rice, the yield survey by representative-hill method was carried out in the rice fields in and around the model areas. The number of samples analized for yield survey was 142 and 57 on lowland and upland rice, respectively. The sites sampled, rice varieties, and yield components, i.e., number of hills per square meter, number of panicles per hills, number of grains per panicle, percentage of ripened grains and weight of 1,000 ripened grains and estimated yield per ha are given in Table FC-1(1/4)-(4/4).

The unit yield can be expressed by the following equation:

Unit yield (ton/ha)
= Number of hills per square meter
x Number of panicles per hill
x Number of grains per panicle
x Percentage of ripened grains
x 1,000 grains weight (in gram)
x 10,000 (conversion to yield per ha in gram)
π 1,000,000 (conversion to metric ton in weight)

The results of the yield survey on both lowland and upland rice are summarized as follows:

(Unit: ton/ha)

	Xai	Beng	Hun	Average
Lowland rice	2.4	2.7	2.6	2.6
Upland rice	1.2	1.5	1.6	1.4

The average unit yield of lowland and upland rice is 2.6 and 1.4 tons per ha, respectively. The unit yield of upland rice in the above table is obtained from slash-and-burn cultivation areas.

The yield of rice can be increased through improvement of defect involved in each yield component. In order to find the reasons for the present low rice yield, the relation between unit yield and each yield component was examined (see Fig. FC-1). There is a clear correlation between yield and number of grains per square meter, except lowland rice in Hun area. The

yield of lowland rice in Hun area shows high correlation between the ripened grain percentage. It is assumed based on the fact that the rice in Hun area has been affected by some damages such as disease, drought, etc. The neck node blast observed in very wide area in the model area and that seems as one of causes of the low yield. The most important factor for increase of rice yield in the model areas is the number of grains per square meter together with increase in ripened grain percentage.

The most decisive factor is the number of grains per panicle, which is generally determined during the period of 25 days before flowering. This period is included in the stage of panicle formation which is sensitive to lack of irrigation water and nitrogen deficiency of rice plant. The effect of irrigation water and N-fertilizer on rice yield should be considered on water management and fertilizer application practices at the proper time and proper quantities.

An another yield component, the number of panicles per hill is determined in early stage of plant growth, generally before maximum tiller number stage, and the measures to increase the number of panicles per square meter are to:

(1) raise the healthy seedlings,
(2) apply basal fertilizers before transplanting,
(3) transplant in shallow depth,
(4) suppress the-bearing and late-emerging tillers, and
(5) select lodging resistant varieties.

3.1.2 Characteristics of Local Rice Varieties

The yield trial of the rainfed lowland glutinous rice was made in the field of Oudomxay Agriculture School 1991, under the Lao-IRRI project in order to evaluate popular rainfed lowland rice varieties in Oudomxay Province in comparison with some Thai-IRRI varieties. The yields, rank, flowering date and plant height in cm are listed below:

	Variety/Line	Yield (ton/ha)	Rank	FD	Ht (cm)
1	Meuang Nga	4.4	01	12/10	179
2	Me To	3.3	06	12/10	169
3	Leuang	3.9	03	20/10	172
4	Kab Lay	3.0	07	29/09	161
5	Wuey Nawng 62 M	1.7	08	13/10	165
6	KKNLR75051-PMI-65-3-1-1	3.4	05	25/09	101
7	IR4369-UBN-507-3-1-2-2	4.1	02	27/09	116
8	IR43064-UBN-54-1-3-2-1	3.6	04	12/09	111
9	SPTLR82022-PRE-12-3-1-GM-7	1.5	09	10/09	na

Note: FD, flowering date, Ht, plant height (seeded on June 10, 1991).
Source: National Rice Research Program and Lao-IRRI Project, 1991.

In terms of yield performance, only two lines: Meuang Nga and IR4369-UBN-507-3-1-2-2 reached over 4 tons level. As seen in the table, the plant height of local varieties are about 50 cm higher than those of Thai-IRRI lines. These local varieties are of generally lodging-susceptible and non-fertilizer response. To avoid the lodging damage the short maturing and short stem varieties such as IR4369-UBN-507-3-1-2-2 should be selected.

3.2 Present Cropping Pattern

The present cropping pattern in the model areas is summarized as follows and illustrated in Fig. FC-2.

(Unit: ha)

Crop	Xai	Beng	Hun
Lowland Rice	310	234	184
Upland Rice	0	5	19
Sesame	0	0.5	2
Tobacco	0	2	0

The present agriculture in the model areas mostly depends on lowland rice cultivation. Besides the lowland rice, about 5 and 19 ha of upland rice are cultivated in Beng and Hun model areas, respectively. The other main crops grown in the upland rice field is sesame and tobacco. Sesame is usually grown mixed with upland rice in about 10% of the area. Tobacco is grown mainly in Beng district after upland rice, and the planted area of tobacco is estimated at about 40% of the upland area.

3.3 Present Farming Practices

Present farming practices prevailing in the model areas were investigated on the main crops and summarized in Table FC-2. Most of the farming works are done by manual labour, except only the field preparation by using buffalo. Upland rice and other upland crops are usually planted to a hole made by planting stick without soil preparation such as ploughing.

Sesame is usually planted mixed with upland rice, and the area is assumed at about 10% of the upland rice area. The farmers grow tobacco for self-consumption and also for sale. In Beng area, tobacco is grown commonly after upland rice. Tobacco is usually sun-cured and sold to market.

The main pests and disease observed during the survey on lowland rice were gall midge, stem borers and neck node blast. Neck node blast was observed in both lowland and upland rice field very widely all over the model areas.

In order to grasp the required labour for the lowland and upland rice farming, the farmers interview survey was carried out in the model areas. The result is summarized as follows:

Lowland Rice		Upland Rice	
Work Item	Required Labour (man/day)	Work Item	Required Labour (man/day)
Nursery	10	Fencing	16
Plowing	37	Slashing	38
Transplanting	28	Burning	5
		Sowing	17
Weeding	17	Weeding	56
Reaping	27	Reaping	27
Threshing	24	Threshing	19
Transportation	5	Transportation	20
Total	148	Total	198

Source: Farm survey in 1992 (average of 13 sample farmers).

From the above table, the labour requirement for weeding in upland rice cultivation is over three times that in the lowland rice cultivation, and also for the transportation of products, 20 man-days, four times that in the lowland rice cultivation. The survey of labour requirement shows that the upland rice cultivation is very labour consuming farming with very low productivity.

3.4 Crop Yield and Production

The average yields of secondary crops such as sesame and tobacco are estimated based on the district data and information from farmers obtained through by door-to-door interviews in the respective model areas. The cultivation area, unit yield and production by crop are summarized as follows:

Model Area	Crops	Cultivated Area (ha)	Yield (ha/ton)	Production (ton)
Xai	Lowland rice	310	2.4	744
Beng	Lowland rice	234	2.7	632
	Upland rice	5	1.5	8
	Sesame*	0.5	0.8	0.4
	Tobacco**	2	3.2	6.4
Hun	Lowland rice	199	2.6	517
	Upland rice	19	1.6	30
	Sesame*	1.9	0.8	1.5
Model/Area Total	Lowland rice	728	-	1,893
	Upland rice	24	-	38
	Sesame	2.4	-	1.9
	Tobacco	30	-	96

Note: * means mixed cultivation with upland rice.
** yield is in raw leaf.

The estimated production of rice is 1,893 tons from lowland rice field and 38 tons from upland rice field, and the total 2,021 tons of rice are produced in the entire model area at present. The production of secondary crops is 6.4 tons of tobacco in the dry season upland rice field in Beng and about 2 tons of sesame in total from Beng and Hun, by mixed cultivation with upland rice.

4. AGRICULTURAL DEVELOPMENT PLAN

4.1 Agricultural Development in Model Areas

4.1.1 Change in Agricultural Land Use

In Xai, Beng and Hun model areas, 378, 337 and 323 ha of land are demarcated for the irrigation development purpose, respectively. After completion of the construction works of the Model Areas Development Scheme (the Scheme), these areas would be changed into the new proportion in terms of land use categories as follows:

(Unit: ha in net)

Land Use	Present			With Project		
	Xai	Beng	Hun	Xai	Beng	Hun
Lowland rice field	310	234	199	302	270	258
Dike, canals etc.	55	41	35	76	67	65
Upland field	0	5	19	0	0	0
Bush and grass land	13	57	70	0	0	0
Total	378	337	323	378	337	323

As seen above, lowland rice field in Xai model area will decrease from 310 ha to 302 ha, while those in Beng and Hun model areas with increase by opening new rice field of 36 ha and 59 ha, respectively. The present upland field, bush and grass land will entirely be used for construction of dikes and canals or expansion of rice field. The expected lowland rice field with project condition in Beng and Hun model areas would be 270 ha and 258 ha, respectively, as shown in the above.

4.1.2 Proposed Cropping Pattern

(1) Selection of Crops

For preliminary study on the optimum cropping patterns to be proposed in the model areas, climatic conditions, seasonal irrigation water availability and familiarity of crops to the farmers are firstly studied as follows:

(i) Sunshine hours

Monthly mean sunshine hours range from 2.6 hr/day in June of the wet season to 6.0 hr/day in May of the dry season. The annual

average is 4.7 hr/day, which would be enough for crop cultivation in the model areas.

(ii) Air temperature

The mean monyhly minimum temperature of 9.6°C occurs in December. In view of temperature, the nursery raising of the dry season rice should be avoided in this period due to slightly low temperature for normal growth of seedlings. However, onion and garlic would not have any problem in their growth during this season.

(iii) Irrigation water availability

According to the result of water balance study (see ANNEX-FD Irrigation), enough irrigation water would be available for wet season lowland rice cultivation in each model area. However, available irrigation water for dry season lowland rice cultivation is limited only to Xai model area for about 125 ha.

(iv) Familiarity of crops

Kind of crops to be selected for the model areas would be the best one which is already familiarized with cultivation practices at the farmers' field level.

(v) Selection of crops

The principal policy of the government's national development plan is to increase food crops and to control slash-and-burn cultivation. In line with this national policy, Oudomxay province is now promoting introduction in the dry season lowland rice to the province from the crop season of 1992/93. The rice seed of 6 tons of K K 10 (glutinous) variety is introduced from Thailand. The allotted area for cultivation of the variety is 42, 30, and 30 ha in Xai, Beng and Hun districts.

Most of rice varieties grown in the model areas are glutinous. However, some farmers have made an attempt to grow non-glutinous rice in Xai district. These farmers are using rice variety of IRR-708, and have a good

record more than 4.2 tons per ha on an average, using a small quantity of yard manure. Non-glutinous rice varieties are usually higher than glutinous varieties in productivity. Therefore, it is proposed to introduce non-gultinous rice to raise production in the area. The area planted with non-glutinous rice is assumed to be about 30% of the total paddy field for future with project conditions, not for all area, because the farmers still prefer glutinous rice.

Taking into account the basic requirement for crop cultivation and provincial policy mentioned above, the wet season lowland rice and dry season lowland rice are selected as the main crop. The cultivation of lowland rice with is already familiar to farmers in the model areas, except for dry season lowland rice.

Recommendable glutinous rice varieties will be IR-43069-UBN-507-3-1-2-2, SK2-9-1 and RD-16, and rice SPTLR82022-PRE-26-2-3-GM-18 and SPTLR82074-PRE-6-2-3-GM-6 for non-glutinous rice. The characteristics of these varieties are shown in Table FC-3(1/4)-(4/4).

(2) Proposed Cropping Pattern and Crop Intensity

After the completion of the scheme, most of the existing rice field will be up-graded, and more intensive use of rice field will become possible. The adequate supply of irrigation water will lead to certain change in crops and cropping patterns within the model areas. It is difficult, however, to forecast how the farmers will change their cultivation pattern of crops. The following basic principles which govern the cropping pattern under the scheme are considered:

(i) The crops and cropping pattern must create maximum benefits for the farmers, and be familiar to the farmers.
(ii) The crops and cropping pattern must make optimum utilization of water to be supplied by the scheme.
(iii) The crops and cropping pattern should be practical with the limited number of family labour, etc.

In due consideration of the basic principles described above, double cropping of rice in Xai and lsingle cropping of owland rice in wet season in Ben and Hun model areas due to limitation of irrigation water are proposed.

The proposed cropping calender in the model areas will be as follows:

Crops		Seeding	Transplanting	Harvest
Dry season lowland rice				
Xai	125 ha	Jan.	March	May
Wet season lowland rice				
Xai	302 ha	Jun.	Jul. early Aug.	Oct. early Dec.
Beng	270 ha	Jun.	Jul. early Aug.	Oct. early Dec.
Hun	258 ha	Jun.	Jul. early Aug.	Oct. early Dec.
Total	955 ha			

The proposed cropping patterns in the model areas are summarized below and illustrated in Fig. FC-4.

(Unit: ha)

Crops	Xai	Beng	Hun	Total
Lowland rice field	302	270	258	830
Wet season crop	302	270	258	830
Dry season crop	125	0	0	125
Total cropping area	427	270	258	955
Cropping intensity (%)	141	100	100	115

The planted area for lowland rice in the wet season will be 302, 270, 258 ha for Xai, Beng and Hun area, respectively. While the dry season rice is planted only in Xai model area for 125 ha. The overall cropping intensity in the model areas will be 115%.

4.1.3 Proposed Farming Practices

Traditional lowland rice is grown during the wet season only. Usually there is no second cropping either before or after the lowland rice. Since double cropping of lowland rice in a year could be introduced to Xai model area, however, the proposed farming practices are described on the lowland rice cultivation both in the dry and wet seasons.

(1) Dry Season Lowland Rice

(i) Selection of crops and nursery raising

The required amount of seed is 40 kg per ha. The certified extension rice seed have to be prepared and be selected by using a solution of 1.13 specific gravity before incubation. The selected seed also have to be disinfected by using adequate disinfectant like Benlate. Incubation

practices before sowing are recommended for obtaining high germination ratio.

Most of farmers in the model areas are not familiar with cultivation of dry season lowland rice at present. The nursery preparation for the dry season rice should be started from the beginning of January to avoid the coolest period in December.

Protected-semi-irrigated rice nursery is recommended in order to protect young seedlings from cool air temperature by means of covering the seed bed by husk charcoal and vinyl sheet. The area of nursery required is approximately 400 square meter per one ha of rice field. The fertilizers are essential. The required amount of N-fertilizer would be 10 grams per square meter of nursery bed. Careful water management is also very important for healthy growth of seedlings. The nursery period will take about 25 days after sowing.

(ii) Field preparation

The land preparation of the rice field is mainly carried out by animal power. The plowing is made by local type ox-plow with a depth of about 15 cm. The harrowing practice should be done at least two times. Puddling work is also required under submerged condition by animal power. Then leveling work is done using animal draft equipment. During these operations, field dike maintenance should be made for effective water management and weeds control on the dikes.

(iii) Transplanting

The transplanting is made by manual labour with a spacing of 30 cm x 15 cm, which makes 22.2 number of hills per square meter, and with 2 to 3 seedlings per hill. The irrigation water has to be drained just before transplanting so that shallow transplanting in depth can be made.

(iv) Fertilizer application

Proper application of fertilizer is essential for full exploitation of agricultural potential under irrigation condition. The soils of the model

areas are generally poor in plant nutrients, especially nitrogen and phosphorous. These chemical elements have to be supplemented by fertilization. Considering soil condition, at least N: 30 kg, P: 15 kg per ha are recommendable. About 50% of the total N and 100% of the total P have to be applied as basal dose and the remaining 50% of N should be used as top-dressing at the time of spikelet differentiation stage corresponding to 25 days before heading.

(v) Weeding

After transplanting, weeding is carried out in three times by manual operation, depending on the condition of weed growth. For effective labor saving operation of weeding, it is recommended to introduce rotary weeder.

(vi) Plant protection

As regards the plant protection, application of insecticides is required for control of insects such as, stem borers, gall mdge, etc. As for pesticides, Foriclon, Azodrin, Fosdrin, etc., and for fungicides, Dithane, Benlet, etc. are available in Laos at present . Adequate amount of these chemicals have to be applied for the pest-disease control one or two times in each cropping season. It is recommended that plant protection works should be carried out in a systematic way under the guidance of the extension offices for effective and safe operation.

(vii) Harvesting

Harvesting is carried out by manual. The harvested rice is dried on the ground. Threshing is done by traditional way. In future, treadle thresher will have to be considered to decrease threshing loss.

(2) Wet Season Lowland Rice

In due consideration of the diagnosis results of the present rice yield survey and also of growing season, the improved farming practices of wet season lowland rice are proposed as follows:

(i) Nursery preparation and sowing practices

As proposed for the dry season rice, incubating practice is also recommended for increasing germination rate. Basic fertilizer application and required extent of nursery bed are the same as those in the dry season lowland rice cultivation. However, there is no need to prevent seedlings from cold damage in this nursery period. Effort should be made, putting emphasis on over growth of the seedlings. The duration of nursery raising may be enough for 20 days to 25 days after sowing.

(ii) Field preparation and transplanting

The field preparation and transplanting could be practiced the same ways as for the dry season lowland rice cultivation.

(iii) Fertilizer application

The fertilizer application is proposed at a rate of N: 30 kg and P: 15 kg per ha, and 50% of the total N and 100% of the total P are applied for basal dose. The remaining 50% of N fertilizer is applied for top dressing two times, i.e., just before the maximum tillering stage of about 15 days after transplanting and at the spikelet differentiation stage corresponding to about 25 days before heading stage.

(iv) Plant protection and harvesting

Plant protection and harvesting practices are recommended to be done by the same practices as in the dry season lowland rice cultivation.

4.1.4 Farm Input and Labour Requirement

(1) Farm input

Farm inputs and labour requirements per ha for the proposed farming practices will be as follows:

Inputs	Unit	Quantity
Seed	kg	40
Fertilizer		
N:	kg	30
P:	kg	15
Agro chemicals:		
Pesticides	kg	1
Fungicides	kg	1
Labour inputs	man/day	165

The total requirement of farm inputs and incremental amount in the model areas is calculated as follows:

(Unit: tons)

Inputs	Xai	Beng	Hun	Total
Extension seed				
Glutinous	12.0	7.6	7.2	26.8
No-glutinous	5.2	3.2	3.1	11.52
N. Fertilizer	13.0	8.1	7.7	28.8
P. Fertilizer	6.4	4.1	3.9	14.4
Pesticides	0.40	0.3	0.3	1.0
Fungicides	0.40	0.3	0.3	1.0

Since the extension seeds, chemical fertilizers and agro-chemicals are not used in the model areas at present, extension seeds of both glutinous and non-glutinous varieties, chemical fertilizers of N and P and agro-chemicals will have to be newly introduced into the model areas.

(2) Labour requirement

The present farm labour requirement per ha for lowland rice cultivation is 148 man-day. The labour requirements per ha for lowland rice in both wet and dry season under the improved farming practices will increase to 165 man-day (see Table FC-5). Based on the present cropping patterns in upland rice field related to the model areas and the proposed lowland rice farming, the peak labour requirements are estimated as shown in Table FC-4. As seen in this table, the peak labour requirement for the model areas cultivate the proposed lowland and traditional upland rice will take place in the beginning 10 days of August. The total labour force required at the peak time for each model area is estimated as shown below.

(Unit: man/day)

Conditions	Xai	Beng	Hun
Proposed lowland rice	563	504	532
Traditional upland rice	44	109	38
Peak requirement	604	613	913
Available labour a day	1,168	797	1,045

The total labour requirement at the peak time in each model area will be 604, 613 and 913 labours per day in Xai, Beng and Hun areas, respectively. On the other hand, total available labour force in each model area is estimated at 1,140, 850 and 1,000 labours per day in Xai, Beng and Hun areas. These estimates show that the available labour force in each area would be enough for the proposed farming operations even at the peak time.

4.1.5 Anticipated Crop Yield and Production

After completion of the Scheme, the yield of rice will be stabilized and increased through supply of irrigation water, improvement of farming practices and water management and further expansion of agricultural supporting services. The anticipated unit yield of lowland rice is estimated as follows:

(Unit: tons/ha)

Present yield Model Area	Present Lowland	Target yield of lowland	
		Glutinous	Non-glutinous
Xai Model area	2.4	4.0	4.0
Beng Model area	2.7	4.0	4.0
Hun Model area	2.6	4.0	4.0

Rice production with project conditions will be as follows:

Model Area	Variety	Wet Season		Dry Season		Total	
		Planted Area	Prod. (ton)	Planted Area (ha)	Prod. (ton)	Planted Area (ha)	Prod. (ton)
Xai	Glutinous	211	844	88	352	299	1,196
(302 ha)	Non-glutinous	91	364	38	150	129	514
	Total	302	1,208	125	502	427	1,710
Beng	Glutinous	189	756	0	0	189	756
(270 ha)	Non-glutinous	81	324	0	0	81	324
	Total	270	1,080	0	0	270	1,080
Hun	Glutinous	181	724	0	0	181	724
(258 ha)	Non-glutinous	77	308	0	0	77	308
	Total	258	1,032	0	0	258	1,032
Total	Glutinous	581	2,324	88	352	669	2,676
	Non-glutinous	249	996	38	150	286.5	1,146
	Total	830	3,320	125	502	955	3,822

Note: The planted area for glutinous and non-glutinous rice is about 70% and 30% of the total planted area in each model area.

The present rice production in the model areas is estimated at 2,021 tons in total. After the completion of the Scheme, total rice production from the three model areas would increase to 3,822 tons at full development stage of the Scheme, with 1,801 tons of increment.

Table

Table FC-1 (1/4) Results of Yield Survey (Lowland Rice)

Code	Name of village	Date	Variety	No. of hill/ m2	No.of pani cles/hill	Total grain/ hill	No of ripened grains	% of ripened grain	Weight of ripened grain	% of mois ture	Actual weight grains	Weight of1000 grains	No. of grains /pani.	Yield* per ha.	25% f losses
1	2	3	4	5	6	7	8	9	10.0	11.0	12.0	13.0	14.0	15.0	16.0
Xai															
1	B.Cheng	92.11.04	Do	21	6	339	75	22.1	3.2	17.1	2.6	35.0	12.5	0.6	0.4
2	"	92.11.04	"	27	6	476	345	72.5	14.6	16.1	12.7	36.7	57.5	3.3	2.4
3	"	92.11.04	"	24	7	508	406	79.9	14.3	16.2	12.4	30.4	58.0	3.4	2.6
4	"	92.11.04	do kodao	19	10	994	250	25.2	8.9	17.4	7.2	28.6	25.0	1.7	1.2
5	"	92.11.10	"	18	12	511	228	44.6	10.9	12.8	11.9	52.3	19.0	1.4	1.1
6	"	92.11.10	"	18	10	718	302	42.1	14.3	13.0	15.4	51.0	30.2	1.9	1.4
7	"	92.11.10	"	28	9	460	240	52.2	8.2	13.6	8.4	35.2	26.7	2.4	1.8
8	"	92.11.10	"	18	12	511	228	44.6	10.9	12.8	11.9	52.3	19.0	1.4	1.1
9	"	92.11.10	"	18	10	718	302	42.1	14.3	13.0	15.4	51.0	30.2	1.9	1.4
10	"	92.11.10	"	28	9	460	240	52.2	8.2	13.6	8.4	35.2	26.7	2.4	1.8
11	"	92.11.10	"	26	10	520	254	48.8	9.9	13.3	10.4	41.0	25.4	2.3	1.7
12	"	92.11.12	"	15	9	358	222	62.0	7.6	14.1	7.5	34.0	24.7	1.2	0.9
13	B.Tine	92.11.04	"	13	8	880	485	55.1	21.0	15.9	18.5	38.1	60.6	2.2	1.7
14	"	92.11.04	"	14	10	872	596	68.3	25.4	15.7	22.6	38.0	59.6	2.9	2.2
15	B.Nanok	92.11.10	IRR.708	17	11	1,984	1,052	53.0	39.8	13.7	40.7	38.7	95.6	6.3	4.7
16	"	92.11.10	"	16	9	1,379	765	55.5	27.3	14.0	27.3	35.7	85.0	4.3	3.2
17	"	92.11.10	"	21	13	1,900	927	48.8	35.5	13.5	36.8	39.7	71.3	6.8	5.1
18	"	92.11.10	"	23	14	1,813	792	43.7	28.7	12.7	31.6	39.9	56.6	6.4	4.8
19	"	92.11.10	"	19	10	1,943	1,082	55.7	39.8	13.0	42.8	39.5	108.2	7.2	5.4
20	"	92.11.10	"	17	6	910	481	52.9	18.5	12.1	21.5	44.6	80.2	2.9	2.1
21	B.NAMY	92.11.12	do khao	25	6	400	329	82.3	10.4	13.6	10.7	32.5	54.8	2.9	2.2
22	"	92.11.12	"	18	10	663	470	70.9	14.4	13.4	15.0	32.0	47.0	3.0	2.2
23	"	92.11.12	"	23	8	327	248	75.8	7.6	13.4	7.9	32.0	31.0	2.0	1.5
24	"	92.11.12	Nokkod	18	11	640	478	74.7	15.5	13.5	16.1	33.6	43.5	3.0	2.3
25	"	92.11.12	"	20	11	535	455	85.0	13.6	13.3	14.3	31.5	41.4	3.2	2.4
26	"	92.11.12	"	24	9	600	217	36.2	6.7	13.5	6.9	32.0	24.1	1.8	1.4
27	B.Houaykym	92.11.12	do hom	24	8	690	483	70.0	17.5	14.0	17.5	36.2	60.4	4.1	3.0
28	"	92.11.12	M.Sing	23	14	518	275	53.1	8.4	13.0	9.0	32.9	19.6	2.2	1.7
29	B.Tico	92.11.12	M.Tai	17	10	926	670	72.4	24.6	13.6	25.3	37.8	67.0	4.0	3.0
30	"	92.11.12	"	20	5	500	365	73.0	13.6	14.2	13.4	36.7	73.0	2.6	1.9
31	"	92.11.12	"	19	9	2,020	1,002	49.6	40.7	13.4	42.5	42.4	111.3	6.7	5.0
32	"	92.11.12	"	17	7	842	533	63.3	18.6	12.8	20.3	38.2	76.1	3.2	2.4
33	"	92.11.12	"	19	11	1,088	924	84.9	32.9	13.2	34.9	37.8	84.0	6.1	4.6
34	B.Nalao	92.11.30	M.Nga	32	10	712	527	74.0	17.5	12.3	19.9	37.8	52.7	5.9	4.4
35	"	92.11.30	"	22	9	753	527	70.0	17.5	12.3	19.9	37.8	58.6	4.1	3.0
36	"	92.11.30	Khaluong	30	8	487	143	29.4	5.2	14.0	5.2	36.4	17.9	1.5	1.1
37	"	92.11.30	"	28	7	354	62	17.5	2.2	13.6	2.3	36.5	8.9	0.6	0.5
38	"	92.11.30	"	30	6	395	308	78.0	11.2	14.2	11.0	35.9	51.3	3.2	2.4
39	B.Nasao	92.11.30	M.Nga	30	7	357	171	47.9	6.5	12.8	7.1	41.6	24.4	1.8	1.3
40	"	92.11.30	"	21	11	865	195	22.5	7.2	14.4	7.0	35.9	17.7	1.4	1.1
41	B.Nalee	92.11.30	"	18	9	1,269	722	56.9	25.6	12.2	29.4	40.7	80.2	4.5	3.4
42	"	92.11.30	"	24	7	696	482	69.3	18.4	14.2	18.1	37.6	68.9	4.0	3.0
43	"	92.11.30	"	21	7	742	353	47.6	12.5	13.1	13.4	37.8	50.4	2.6	1.9
		Average		22	9	825	457	57.7	16.9	14.1	17.5	38.8	50.9	3.5	2.4

Note: *: Under condition of 14% of moisture content.

Table FC-1 (2/4) Results of Yield Survey (Lowland Rice)

Code	Name of village	Date	Variety	No. of hill/ m2	No.of panicles/hill	Total grain/ hill	No of ripened grains	% of ripened grain	Weight of ripened grain	% of moisture	Actual weight grains	Weight of1000 grains	No. of grains /pani.	Yield* per ha.	25% of losses
1	2	3	4	5	6	7	8	9	10.0	11.0	12.0	13.0	14.0	15.0	16.0
Beng															
44	B.Bengkham	92.11.18	M.Tai	31	7	622	246	39.5	10.0	13.6	10.3	41.8	35.1	2.7	2.0
45	"	92.11.18	M.Nga	26	7	623	416	66.8	15.4	16.7	12.9	31.0	59.4	3.8	2.8
46	"	92.11.18	"	21	6	970	672	69.3	27.2	17.5	21.8	32.4	112.0	4.9	3.7
47	"	92.11.18	M.Tai	29	6	466	271	58.2	9.4	16.1	8.2	30.2	45.2	2.8	2.1
48	"	92.11.18	M.Nga	24	8	728	548	75.3	23.5	18.0	18.3	33.4	68.5	4.6	3.5
49	"	92.11.18	"	22	7	730	503	68.9	19.9	15.6	17.9	35.5	71.9	3.9	2.9
50	"	92.11.18	M.Tai	21	7	452	302	66.8	14.0	16.3	12.0	39.8	43.1	2.2	1.7
51	"	92.11.18	"	26	10	772	173	22.4	6.6	19.2	4.8	27.8	17.3	1.6	1.2
52	"	92.11.18	"	28	7	809	505	62.4	21.3	15.8	18.9	37.4	72.1	4.9	3.7
53	"	92.11.18	M.Nga	20	8	924	633	68.5	19.5	14.7	18.6	29.3	79.1	4.4	3.3
54	"	92.11.18	M.Tai	25	6	892	517	58.0	20.4	15.7	18.2	35.2	86.2	4.5	3.4
55	"	92.11.18	M.Nga	25	8	600	279	46.5	14.1	18.6	10.6	38.0	34.9	2.4	1.8
56	"	92.11.18	"	19	9	929	663	71.4	25.5	17.7	20.2	30.4	73.7	4.4	3.3
57	"	92.11.18	M.Sing	22	8	758	593	78.2	21.2	16.4	18.1	30.5	74.1	4.6	3.4
58	"	92.11.18	M.Nga	21	7	930	509	54.7	20.6	17.0	17.0	33.3	72.7	3.7	2.8
59	"	92.11.18	M.Tai	22	8	544	381	70.0	14.4	16.1	12.5	32.9	47.6	2.9	2.2
60	B.Benglouang	92.11.18	M.Nga	21	8	836	736	88.0	20.8	18.0	16.2	22.0	92.0	5.4	4.1
61	"	92.11.18	do khao	26	6	623	407	65.3	15.4	16.2	13.3	32.7	67.8	3.7	2.8
62	"	92.11.18	M.Tai	17	5	493	364	73.8	14.7	19.7	10.4	28.7	72.8	2.2	1.6
63	B.Thakad	92.11.18	M.Nga	28	8	685	342	49.9	12.2	13.8	12.4	36.2	42.8	3.4	2.5
64	"	92.11.18	Ito	26	7	534	134	25.1	5.2	14.9	4.9	36.5	19.1	1.2	0.9
65	"	92.11.18	M.Nga	30	7	834	513	61.5	19.8	13.8	20.1	39.2	73.3	5.4	4.0
66	"	92.11.18	"	32	6	577	384	66.6	15.7	15.5	14.2	36.9	64.0	4.3	3.2
67	"	92.11.18	"	26	7	914	614	67.2	25.4	18.8	18.9	30.8	87.7	5.6	4.2
68	"	92.11.18	"	24	6	657	452	68.8	13.8	16.8	11.5	25.4	75.3	3.8	2.8
69	"	92.11.18	Khao	29	5	268	83	31.0	6.1	15.9	5.4	64.7	16.6	0.8	0.6
70	"	92.11.18	"	25	9	727	556	76.5	18.9	17.9	14.8	26.6	61.8	4.9	3.6
71	"	92.11.18	"	18	9	581	447	76.9	13.8	16.9	11.4	25.6	49.7	2.8	2.1
72	"	92.11.18	M.Nga	28	6	745	389	52.2	15.4	17.3	12.5	32.0	64.8	3.8	2.9
73	"	92.11.18	"	27	7	919	605	65.8	23.6	14.9	22.2	36.7	86.4	5.7	4.3
74	"	92.11.18	"	30	8	719	514	71.5	20.6	18.8	15.3	29.8	64.3	5.4	4.0
75	"	92.11.18	"	28	7	853	702	82.3	28.0	16.1	24.3	34.7	100.3	6.9	5.2
76	"	92.11.18	M.Tai	25	7	560	143	25.5	5.7	17.3	4.6	32.3	20.4	1.3	0.9
77	"	92.11.18	M.Nga	28	6	391	164	41.9	6.4	16.3	5.5	33.5	27.3	1.6	1.2
78	"	92.11.18	"	31	5	925	613	66.3	23.6	17.8	18.6	30.3	122.6	6.7	5.0
79	"	92.11.18	"	24	6	850	610	71.8	22.8	16.9	18.9	31.0	101.7	5.1	3.8
80	"	92.11.18	Khao	24	11	470	393	83.6	16.1	16.1	14.0	35.6	35.7	3.3	2.5
81	B.Benglouang	92.12.04	Fouengkham	31	5	509	171	33.6	6.3	12.8	6.9	40.3	34.2	1.9	1.4
82	"	92.12.04	"	21	8	687	311	45.3	11.2	12.5	12.5	40.3	38.9	2.3	1.7
83	B.Bengkham	92.12.04	"	24	6	633	193	30.5	6.5	13.0	7.0	36.3	32.2	1.6	1.2
84	"	92.12.04	"	24	8	946	480	50.7	16.8	14.5	16.2	33.8	60.0	4.0	3.0
85	"	92.12.04	"	26	6	857	341	39.8	12.4	13.3	13.1	38.3	56.8	3.1	2.3
86	"	92.12.04	"	24	9	767	301	39.2	10.7	14.4	10.4	34.6	33.4	2.5	1.9
87	"	92.12.04	M.Nga	24	7	491	421	85.7	13.4	14.1	13.3	31.6	60.1	3.5	2.7
88	"	92.12.04	"	29	8	571	370	64.8	13.2	12.5	14.8	40.0	46.3	3.8	2.8
89	B.Houayla	92.12.04	"	30	8	479	320	66.8	11.0	13.4	11.5	35.9	40.0	3.4	2.5
90	"	92.12.04	Fouengkham	25	9	806	208	25.8	7.2	13.5	7.5	35.9	23.1	1.8	1.4
91	B.Thakad	92.12.04	Makbeat	34	9	423	193	45.6	6.8	13.0	7.3	37.9	21.4	2.3	1.7
92	"	92.12.04	"	34	9	681	414	60.8	14.8	12.9	16.1	38.8	46.0	4.9	3.7
93	"	92.12.04	"	26	8	529	330	62.4	11.3	13.2	12.0	36.3	41.3	3.0	2.3
		Average		26	7	686	409	58.8	15.4	15.8	13.6	34.4	57.5	3.6	2.7

Note: *: Under condition of 14% of moisture content.

Table FC-1 (3/4) Results of Yield Survey (Lowland Rice)

Code	Name of village	Date	Variety	No. of hill/ m2	No.of panicles/hill	Total grain/ hill	No of ripened grains	% of ripened grain	Weight of ripened grain	% of moisture	Actual weight grains	Weight of1000 grains	No. of grains /pani.	Yield* per ha.	25% of losses
1	2	3	4	5	6	7	8	9	10.0	11.0	12.0	13.0	14.0	15.0	16.0
HUN															
94	B.Nakham Tai		M.Beng	30	7	518	535	103.3	13.7	13.1	14.6	27.4	76.4	5.6	4.2
95	"	92.11.16	"	46	5	411	272	66.2	9.9	15.2	9.1	33.5	54.4	4.4	3.3
96	"	92.11.16	"	15	14	1,054	720	68.3	27.8	17.3	22.5	31.2	51.4	3.8	2.8
97	"	92.11.16	"	29	6	587	330	56.2	14.4	18.2	11.1	33.6	55.0	3.3	2.5
98	"	92.11.16	"	22	10	863	552	64.0	21.7	16.2	18.8	34.0	55.2	4.3	3.2
99	"	92.11.16	"	24	7	736	467	63.5	17.2	17.7	13.6	29.1	66.7	3.9	2.9
100	"	92.11.16	Tam	30	6	720	454	63.1	18.7	18.0	14.5	32.0	75.7	4.8	3.6
101	"	92.11.16	Mehang	20	10	912	803	88.0	28.3	16.9	23.4	29.2	80.3	5.6	4.2
102	"	92.11.16	"	20	8	712	260	36.5	10.8	14.2	10.6	41.0	32.5	1.8	1.4
103	"	92.11.16	Pa	28	6	702	539	76.8	19.1	14.2	18.8	34.9	89.8	5.3	4.0
104	"	92.11.16	"	27	6	726	560	77.1	18.6	13.8	18.9	33.7	93.3	5.3	4.0
105	"	92.11.16	"	42	7	358	217	60.6	8.8	13.8	8.9	41.1	31.0	3.2	2.4
106	"	92.11.16	"	22	6	923	678	73.5	23.7	16.9	19.6	29.0	113.0	5.2	3.9
107	"	92.11.16	"	21	7	729	533	73.1	19.2	15.1	17.8	33.4	76.1	3.9	2.9
108	"	92.11.16	"	25	5	648	474	73.1	17.6	19.1	12.9	27.2	94.8	4.1	3.1
109	"	92.11.16	"	24	7	675	486	72.0	18.5	18.6	13.9	28.7	69.4	4.1	3.1
110	"	92.11.16	"	21	8	1,010	680	67.3	26.4	17.7	20.9	30.7	85.0	5.0	3.7
111	"	92.11.16	"	25	5	684	474	69.3	17.6	17.0	14.5	30.6	94.8	4.1	3.1
112	"	92.11.16	"	24	7	685	462	67.4	20.1	17.2	16.4	35.4	66.0	3.9	2.9
113	"	92.11.16	"	19	11	929	660	71.0	22.9	15.2	21.1	32.0	60.0	4.4	3.3
114	B.Somsay	92.11.17	"	27	6	433	301	69.5	11.6	18.2	8.9	29.6	50.2	2.8	2.1
115	"	92.11.17	"	32	6	426	294	69.0	12.2	16.9	10.1	34.4	49.0	3.3	2.5
116	"	92.11.17	"	29	6	538	372	69.1	14.4	12.8	15.8	42.3	62.0	3.8	2.8
117	"	92.11.17	"	32	8	826	547	66.2	21.5	17.0	17.7	32.4	68.4	6.1	4.6
118	"	92.11.17	"	30	6	446	275	61.7	17.5	15.8	15.5	56.4	45.8	2.9	2.2
119	"	92.11.17	"	37	6	628	454	72.3	29.5	18.1	22.8	50.3	75.7	5.9	4.4
120	"	92.11.17	"	37	6	390	180	46.2	8.3	18.5	6.3	34.9	30.0	2.3	1.7
121	B.NakhamNeu	92.11.17	Khao Tam	39	6	868	162	18.7	6.0	17.2	4.9	30.1	27.0	2.2	1.7
122	"	92.11.17	N.Beng	33	7	404	294	72.8	11.7	17.0	9.6	32.8	42.0	3.4	2.5
123	"	92.11.17	Khao Tam	39	7	691	84	12.2	3.0	18.5	2.3	27.0	12.0	1.1	0.9
124	"	92.11.17	Khao Pa	29	7	688	412	59.9	15.7	18.2	12.1	29.3	58.9	4.2	3.1
125	"	92.11.17	M.Beng	41	4	328	93	28.4	3.4	15.0	3.2	34.1	23.3	1.3	1.0
126	"	92.11.17		41	6	513	321	62.6	12.1	13.8	12.3	38.2	53.5	4.6	3.5
127	"	92.11.17	Khao Tam	33	7	709	358	50.5	14.4	13.8	14.6	40.8	51.1	4.1	3.1
128	"	92.11.17	M.Beng	35	5	587	345	58.8	13.4	16.8	11.2	32.4	69.0	4.2	3.2
129	"	92.11.17	KhaoTam	38	5	615	173	28.1	5.9	19.4	4.3	24.6	34.6	2.3	1.7
130	"	92.11.17	"	59	4	447	120	26.8	4.2	16.6	3.5	29.5	30.0	2.5	1.9
131	"	92.11.17	"	33	6	792	274	34.6	9.7	16.5	8.2	30.0	45.7	3.2	2.4
132	"	92.11.17	"	20	8	712	260	36.5	10.8	14.2	10.6	41.0	32.5	1.8	1.4
133	"	92.11.17	"	32	4	489	234	47.9	8.6	19.0	6.3	27.1	58.5	2.6	2.0
134	B.Somxai	92.12.03	Mehang	28	9	488	323	66.2	10.0	13.7	10.2	31.6	35.9	3.2	2.4
135	"	92.12.03	"	29	9	1,102	583	52.9	19.2	12.2	22.0	37.8	64.8	5.9	4.4
136	"	92.12.03	"	30	6	511	223	43.6	7.0	13.3	7.4	33.0	37.2	2.3	1.8
137	"	92.12.03	"	34	7	727	218	30.0	7.4	13.4	7.7	35.5	31.1	2.6	1.9
138	"	92.12.03	M.Nga	27	8	647	164	25.3	5.2	15.4	4.7	28.8	20.5	1.5	1.2
139	"	92.12.03	"	34	5	303	81	26.7	2.7	13.7	2.8	34.1	16.2	1.0	0.7
140	"	92.12.03	"	37	6	427	169	39.6	6.0	13.5	6.2	36.8	28.2	2.2	1.6
141	"	92.12.03	"	26	7	504	170	33.7	5.6	13.2	5.9	34.9	24.3	1.5	1.2
142	"	92.12.03	"	29	11	1,194	365	30.6	11.3	13.3	11.9	32.6	33.2	3.7	2.8
143	"	92.12.03	"	27	6	516	129	25.0	4.2	12.7	4.6	35.9	21.5	1.2	0.9
		Average		30	7	651	363	55.1	13.8	15.9	12.1	33.7	53.1	3.5	2.6

Note: *: Under condition of 14% of moisture content.

Table FC-1 (4/4) Results of Yield Survey (Upland Rice)

Code	Name of village	Date	Variety	No. of hill/ m2	No.of panicles/hill	Total grain/ hill	No of ripened grains	% of ripened grain	Weight of ripened grain	% of moisture	Actual weight grains	Weight of1000 grains	No. of grains /pani.	Yield* per ha.	25% of losses
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Xai															
1	Nasao	92.10.29	Kan	14	9	759	552	72.7	21.7	15.7	19.4	35.1	61.3	2.7	1.9
2	Nasao	92.10.29	Pheepy	14	6	484	73	15.1	3.1	14.7	3.0	40.6	12.2	0.4	0.3
3	Nasao	92.10.29	Phee	12	8	528	292	55.3	13.5	12.3	15.3	52.5	36.5	1.8	1.3
4	Nasao	92.10.29	Pheekhao	12	5	490	306	62.4	14.9	16.3	12.8	41.7	61.2	1.5	1.1
5	Nasao	92.10.29	"	12	10	861	375	43.6	18.5	15.8	16.4	43.6	37.5	2.0	1.4
6	Nasao	92.10.29	"	18	8	744	244	32.8	10.5	12.5	11.8	48.4	30.5	2.1	1.5
7	Houaykhum	92.10.29	Viat	11	8	868	528	60.8	21.1	16.6	17.8	33.7	66.0	2.0	1.4
8	Houaykhum	92.10.29	Laypy	8	6	642	258	40.2	12.0	12.3	13.7	52.9	43.0	1.1	0.8
9	Houaykhum	92.10.29	Khuaydoan	14	5	339	179	52.8	9.8	12.8	10.7	59.7	35.8	1.5	1.0
10	Houaykhum	92.10.29	Unknown	14	6	690	520	75.4	22.4	12.5	25.0	48.1	86.7	3.5	2.5
11	Houaykhum	92.10.29	"	11	7	476	156	32.8	7.2	13.4	7.5	48.4	22.3	0.8	0.6
12	Houaykhum	92.10.29	"	13	5	241	60	24.9	2.6	15.9	2.3	38.2	12.0	0.3	0.2
13	Houaykhum	92.10.29	"	14	6	465	280	60.2	14.0	16.9	11.6	41.4	46.7	1.6	1.1
		Average		13	7	584	294	48.4	13.2	14.4	12.9	44.9	42.4	1.2	1.1
14	Thakad	92.10.28	Pheepy	11	9	692	77	11.1	2.0	13.3	2.1	27.3	8.6	0.2	0.2
15	Thakad	92.10.28	Dengpy	8	8	682	282	41.3	13.2	16.6	11.1	39.4	35.3	0.9	0.6
16	Thakad	92.10.28	Pheepy	12	10	1,284	544	42.4	14.0	16.5	11.9	21.9	54.4	1.4	1.0
17	Thakad	92.10.28	"	14	10	1,053	807	76.6	22.2	16.3	19.1	23.7	80.7	2.7	1.9
18	Thakad	92.10.28	"	13	18	2,400	1,317	54.9	42.5	16.5	36.1	27.4	73.2	4.7	3.3
19	Thakad	92.10.28	Dongpy	7	6	904	270	29.9	13.0	15.9	11.4	42.4	45.0	0.8	0.6
20	Bengkhan	92.10.28	Khangpy	9	13	2,118	1,302	61.5	41.0	12.8	44.7	34.4	100.2	4.0	2.8
21	Bengkhan	92.10.28	"	14	7	1,093	535	48.9	23.4	16.8	19.5	36.4	76.4	2.7	1.9
22	Bengkhan	92.10.28	"	7	9	1,163	307	26.4	13.0	16.8	10.9	35.4	34.1	0.8	0.5
23	Bengkhan	92.10.28	Pheekhao	13	10	932	481	51.6	21.5	16.9	17.8	37.0	48.1	2.3	1.6
24	Bengkhan	92.10.28	Kan	14	7	1,441	166	11.5	5.8	19.7	4.1	24.8	23.7	0.6	0.4
25	Bengkhan	92.10.28	Khangpy	13	10	1,191	647	54.3	26.7	16.8	22.3	34.4	64.7	2.9	2.0
26	Bengkhan	92.10.28	Pheedong	13	5	1,011	743	73.5	32.0	12.1	37.1	50.0	148.6	4.8	3.4
27	Pandua	92.10.28	Pheepy	15	11	889	685	77.1	19.6	13.5	20.3	29.7	62.3	3.0	2.1
28	Pandua	92.10.28	Phekhao	17	16	1,438	884	61.5	24.1	16.2	20.9	23.6	55.3	3.6	2.5
29	Pandua	92.10.28	"	12	9	1,405	894	63.6	26.8	15.6	24.0	26.9	99.3	2.9	2.0
30	Pandua	92.10.28	Pheepy	17	6	688	191	27.8	5.0	13.3	5.3	27.6	31.8	0.9	0.6
31	Pandua	92.10.28	Pheepy	14	11	973	572	58.8	17.5	17.5	14.0	24.5	52.0	2.0	1.4
32	Pandua	92.10.28	Pheekhao	11	14	1,595	1,015	63.6	27.0	18.4	20.5	20.2	72.5	2.3	1.6
33	Pandua	92.10.28	Pheepy	11	8	754	349	46.3	8.0	13.2	8.5	24.3	43.6	0.9	0.7
34	Pandua	92.10.28	Pheekhao	15	7	683	407	59.6	9.7	11.7	11.6	28.5	58.1	1.7	1.2
		Average		12	10	1,161	594	49.6	19.4	15.5	17.8	30.5	60.4	1.6	1.5
35	Na fang	92.10.26	Phee Kong	12	13	1,156	908	78.5	30.2	15.5	27.3	30.0	69.8	3.3	2.3
36	Na fang	92.10.26	Khang py	11	7	842	555	65.9	29.1	14.5	28.2	50.8	79.3	3.1	2.2
37	Na fang	92.10.26	Khang deng	13	7	1,143	753	65.9	39.0	16.2	33.8	44.9	107.6	4.4	3.1
38	Na fang	92.10.26	Phee	14	9	699	391	55.9	14.3	15.6	12.9	32.9	43.4	1.8	1.3
39	Na fang	92.10.26	Pack	11	10	1,028	576	56.0	22.3	12.2	25.6	44.4	57.6	2.8	2.0
40	Na fang	92.10.26	Phee Kang	12	16	1,454	649	44.6	23.0	16.1	20.0	30.8	40.6	2.4	1.7
41	Chan tai	92.10.27	Khaopy	10	7	1,166	990	84.9	35.6	16.3	30.6	30.9	141.4	3.1	2.1
42	Chan tai	92.10.27	"	11	10	600	436	72.7	19.7	16.2	17.0	39.0	43.6	1.9	1.3
43	Chan tai	92.10.27	khao	13	11	932	777	83.4	34.8	15.6	31.2	40.2	70.6	4.1	2.8
44	Chan tai	92.10.27	Deng	11	14	1,600	993	62.1	37.9	14.7	36.2	36.4	70.9	4.0	2.8
45	Chan tai	92.10.27	Tasadpy	12	4	677	546	80.6	21.9	16.2	19.0	34.7	136.5	2.3	1.6
46	Chan tai	92.10.27	Ngiao	12	8	533	410	76.9	15.7	15.4	14.3	34.8	51.3	1.7	1.2
47	Ban na	92.10.27	Ngeo	9	7	765	490	64.1	22.2	16.1	19.4	39.5	70.0	1.7	1.2
48	Ban na	92.10.27	Doluong	15	7	526	246	46.8	8.9	15.6	8.0	32.5	35.1	1.2	0.8
49	Ban na	92.10.27	"	10	9	1,238	750	60.6	28.7	16.6	24.2	32.3	83.3	2.4	1.7
50	Ban na	92.10.27	Dengkang	12	12	1,202	556	46.3	27.2	16.2	23.5	42.3	46.3	2.8	2.0
51	Ban na	92.10.27	Khao	13	8	570	421	73.9	18.4	12.3	21.0	49.9	52.6	2.7	1.9
52	Ban na	92.10.27	"	17	11	668	373	55.8	15.8	16.6	13.4	35.8	33.9	2.3	1.6
53	Ban na	92.10.27	Deng	7	22	1,850	728	39.4	28.8	15.2	26.5	36.4	33.1	1.9	1.3
54	Ban na	92.10.27	Mong	10	8	1,595	558	35.0	18.2	15.9	16.0	28.7	69.8	1.6	1.1
55	Ban na	92.10.27	Khaokang	9	10	808	508	62.9	20.0	13.5	20.7	40.7	50.8	1.9	1.3
56	Ban na	92.10.27	Deng	14	10	1,249	888	71.1	37.1	16.1	32.3	36.4	88.8	4.5	3.2
57	Ban na	92.10.27	"	11	5	926	652	70.4	27.2	16.0	23.9	36.6	130.4	2.6	1.8
		Average		12	10	1,010	615.4	63.2	25.0	15.4	22.8	37.4	69.9	1.7	1.6

Note: *: Under condition of 14% of moisture content.

Table FC-2 Present Farming Practices for Main Crops

Items	Unit	Lowland rice	Upland rice	Maize (mized with rice)*	Sesame (mixed with rice)*	Tobacco	Garlic
A. Gross income							
1) Unit yield	(ton/ha)	2.6	1.4	1.80	0.8	3.2	1.4
2) Unit price	(Kip/kg)	80	80	90	280	30	100
B. Production cost					34		
1) Labor force	man -day/ha						
Field preparation		37	43	0	0	12	20
Fencing		0	16	0	0	5	10
Nursery preparation		10	0	0	0	30	0
Trans planting/seeding		28	17	25	3	15	20
Weeding		17	56	0	0	25	15
Irrigation/Watering		0	0	0	0	0	0
Harvesting/threshing		56	66	35	27	60	20
sub-total		148	198	60	30	147	85
2) Animal power	head-day/ha						
Land preparation		15	0	0	0	0	0
Hired		5	0	0	0	0	0
3) Materials							
Seed/seedling	kg/ha	50	80	40	4	0.4	600

Note: * The planted area area of sesame is estimated about 10% of of the upland rice filed, on average for 1987 - 1991. Seame is usually grown mixed with upland rice.

Table FC-3 (1/4) Yield and Some Agronomic Characteristics of the Entries In the Glutinous Rice Yield Trial, Naphok, 1990/91 Dry Season

Entry No.	Description	Yield (t/ha)	R	Mat (days)	Ht (cm)	Pan/ Hill
01	IR36	3.3	03	130	99	05
02	IR50	2.8	09	133	98	05
03	IR58	3.1	08	136	94	03
04 *	IR64	3.3	04	133	100	05
05	IR66	3.7	01	139	97	03
06	IR72	2.6	11	143	99	03
07	RD23	3.2	06	139	94	07
08	SPR60	2.8	10	144	103	05
09 *	SPR90	3.2	05	128	82	01
10 *	OM80	3.6	02	139	98	01
11 *	SK9-3-1	3.2	07	143	88	03
12 *	CR203	2.3	12	122	76	01

Note: CV = 13.3%, DMRT at 5% level
R = rank, Mat = maturity, Ht = height
Pan = panicle number, SB = stemborer score at deadheart
* = selected for further study
Source: LAO-IRRI Project, 1991, Annual Technical Report

Table FC-3 (2/4) Yield and Some Agronomic Characteristics of Non-glutinous Lowland Rice Entries in Yield Trial Naphok, 1990/91 Dry Season

Entry No.	Description	Yield (t/ha)	R	Mat (days)	Ht (cm)	Pan/ Hill	SB
01	CR203	3.7	01	133	86	15	3
02	CH1	2.8	10	145	78	17	1
03	CH2	3.6	02	135	87	15	5
04	CH3	3.1	08	142	76	13	5
05	CH4	2.6	12	144	84	13	3
06	CH133	3.1	07	142	96	13	5
07 *	OM80	3.5	04	135	94	13	1
08	B1014-bpn-18-1-4	3.4	06	141	90	18	3
09	RD105	2.8	09	136	89	16	5
10 *	IR64	2.8	11	129	81	15	3
11 *	IR72	3.6	03	138	78	20	1
12 *	IR66	3.4	05	122	77	20	1

Note: CV = 13.7%, DMRT at 5% level
R = rank, Mat = maturity, Ht = height, Pan = panicle number
SB = stemborer score at deadheart stage
* = Selected for further study
Source: LAO-IRRI Project, 1991, Annual Technical Report

Table FC-3 (3/4) Yield and Some Agronomic Characteristics of the Entries in Irrigated Lowland Non-glutinous Rice Yield Trial, Naphok, 1991 Wet Season

Entry No.	Description	Yield (t/ha)	R	Mat (days)	Ht (cm)	Pan/ Hill
01	IR36	3.5	06	123	84	16
02	IR50	3.7	05	113	85	15
03	IR58	1.9	17	111	76	15
04	IR64	2.4	16	119	91	14
05	IR66	3.4	07	121	91	14
06	IR72	3.4	08	127	90	13
07	RD23	3.1	12	123	105	11
08	SPR60	2.9	13	127	105	11
09	SPR90	3.7	04	127	114	11
10	OM80	3.2	11	135	107	11
11	SK9-3-1	2.8	14	140	103	11
12	CR203	3.4	09	118	92	13
13	SPTLR82078-PTG-B3-24-1-1	3.3	10	122	121	08
14	SPTLR82087-PTG-B3-57-1-1	2.7	15	141	115	09
15	SPTLR82022-PRE-26-2-3-GM-18	4.7	01	118	105	13
16	SPTLR82074-PRE-6-2-1-GM-6	3.8	03	116	101	15
17	SPTLR82074-PRE-6-2-3-GM-6	3.9	02	126	97	14

Note: CV = 15.6%, DMRT at 5% level
R = rank, Mat = maturity, Ht = plant height
Source: LAO-IRRI Project, 1991, Annual Technical Report

Table FC-3 (4/4) Yield and Some Agronomic Characteristics in Irrigated Lowland Glutinous Rice Yield Trial, Naphok, 1991 Wet Season

Entry No.	Description	Yield (t/ha)	R	Mat (days)	Ht (cm)	Pan/ Hill
01 *	IR43495-CPA-520-3-2-2	4.8	03	140	114	12
02 *	IR43064-UBN-514-1-3-2-1	3.9	11	142	135	11
03 *	RD21G	3.8	12	127	124	11
04 *	SPTLR80146-PRE-7-1-2-2	5.1	01	127	119	11
05 *	SPTLR82022-PRE-12-3-1-GM-7	4.3	06	128	108	12
06 *	NKN7213-62-2-1	3.5	18	135	114	12
07 *	SPTLR75007-145-1-1	4.5	05	141	118	11
08 *	KKN7407-35-3-1-1	4.3	08	140	115	12
09 *	KKNLR75051-PMI-65-3-1-1	4.6	04	139	107	12
10 *	RD10	3.5	17	131	114	12
11 *	SK8-5-1-2	3.5	15	128	94	12
12 *	SK9-6-1	3.3	20	117	96	13
13	IR29	3.4	19	125	116	13
14 *	IR65	3.9	10	136	97	13
15	OM85	3.5	16	126	97	13
16	RD12	4.1	09	127	137	12
17	RD14	3.6	14	127	143	12
18 *	RD18	5.0	02	129	139	12
19 *	RD16	3.7	13	134	146	12
20	IR43506-UBN-520-2-1-1	4.3	07	143	129	11

Note: CV = 12.5%, DMRT at 5% level
R = rank, Mat = maturity, Ht = height, Pan = panicle number
* = Selected for further study
Source: LAO-IRRI Project, 1991, Annual Technical Report

Table FC-4 Required Farm Input and Farm Labour for Lowland Rice Cultivation per Ha

Farming Practices	Labour Requirement	Equipment	Inputs Use per Ha
1. Nursery	10	Oxplow/buffalo	500 m2/ha Seed, 40 kg/ha
2. Plowing	20	Oxplow/buffalo	
3. Basal fertilizer	3	(manpower)	N: 15 kg P: 15 kg
4. Harrowing	10	Harrow/buffalo	
5. Puddling	40	Harrow/buffalo	
6. leveling	3	Leveling board/buffalo	
7. Transplanting	27	(manpower)	
8. Top dressing	2	(manpower)	N: 15 kg
9. Pest control	1	Knapsack sprayer)	
10. Weeding	27	(manpower)	
11. Reaping	27	(manpower)	
12. Threshing	24	(manpower)	
13. Transportation	7	Oxcart/buffalo	
Total	165		

Table FC-5 (1/3) Seasonal Labour Requirement under the Proposed Cropping Pattern in Xai Model Area
(Dry season 125 ha, Wet season 302 ha of lowland and 52 ha of upland rice)

(Unit: man/day)

Month	Season	Lowland Rice						Upland Rice			
		Nur.	LP	TP	WED	HV	Sub-total	LP,TP	WD,HV	Sub-total	Total
Jan.	1	28.6					28.6			0.0	28.6
	2	28.6	74.0				102.6			0.0	102.6
	3	28.6	74.0	75.0			177.6			0.0	177.6
Feb.	1	28.6	74.0	75.0	42.9		220.4			0.0	220.4
	2		74.0	75.0	42.9		191.9			0.0	191.9
	3		74.0	75.0	42.9		191.9			0.0	191.9
Mar.	1				42.9		42.9	63.4		63.4	106.3
	2				42.9		42.9	63.4		63.4	106.3
	3				42.9		42.9	63.4		63.4	106.3
Apr.	1				42.9		42.9	63.4		63.4	106.3
	2					145.0	145.0	63.4		63.4	208.4
	3					145.0	145.0	14.7		14.7	159.7
May	1					145.0	145.0	14.7		14.7	159.7
	2					145.0	145.0	14.7		14.7	159.7
	3						0.0	14.7		14.7	14.7
Jun.	1						0.0	14.7	40.9	55.6	55.6
	2	86.3					86.3	14.7	40.9	55.6	141.9
	3	86.3	223.5				309.8		40.9	40.9	350.6
Jul.	1	86.3	223.5				309.8		40.9	40.9	350.6
	2	86.3	223.5	226.5			536.3		40.9	40.9	577.1
	3		223.5	226.5			450.0		40.9	40.9	490.8
Aug.	1		223.5	226.5	113.3		563.2		40.9	40.9	604.1 *
	2			226.5	113.3		339.8			0.0	339.8
	3				113.3		113.3			0.0	113.3
Sep.	1				113.3		113.3		71.5	71.5	184.8
	2				113.3		113.3		71.5	71.5	184.8
	3				113.3		113.3		71.5	71.5	184.8
Oct.	1				113.3		113.3		71.5	71.5	184.8
	2				113.3		113.3			0.0	113.3
	3					437.9	437.9			0.0	437.9
Nov.	1					437.9	437.9			0.0	437.9
	2					437.9	437.9			0.0	437.9
	3					437.9	437.9			0.0	437.9
Dec.	1						0.0			0.0	0.0
	2						0.0			0.0	0.0
	3						0.0			0.0	0.0

Note: LP: Land Preparation
TP: Transplanting
WD: Weeding
HV: Harvesting

Table FC-5 (2/3) Seasonal Labour Requirement under the Proposed Cropping Pattern in Beng Model Area (Dry season 0 ha, Wet season 270 ha of lowland and 130 ha of upland rice)

(Unit: man/day)

Month	Season	Lowland Rice						Upland Rice			Total	
		Nur.	LP	TP	WED	HV	Sub-total	LP,TP	WD,HV	Sub-total		
Jan.	1						0.0			0.0	0.0	
	2						0.0			0.0	0.0	
	3						0.0			0.0	0.0	
Feb.	1						0.0			0.0	0.0	
	2						0.0			0.0	0.0	
	3						0.0			0.0	0.0	
Mar.	1						0.0	169.6		169.6	169.6	
	2						0.0	169.6		169.6	169.6	
	3						0.0	169.6		169.6	169.6	
Apr.	1						0.0	169.6		169.6	169.6	
	2						0.0	169.6		169.6	169.6	
	3						0.0	39.4		39.4	39.4	
May	1						0.0	39.4		39.4	39.4	
	2						0.0	39.4		39.4	39.4	
	3						0.0	39.4		39.4	39.4	
Jun.	1						0.0	39.4	109.2	148.6	148.6	
	2	77.1					77.1	39.4	109.2	148.6	225.7	
	3	77.1	199.8				276.9		109.2	109.2	386.2	
Jul.	1	77.1	199.8				276.9		109.2	109.2	386.2	
	2	77.1	199.8	202.5			479.4		109.2	109.2	588.7	
	3		199.8	202.5			402.3		109.2	109.2	511.5	
Aug.	1		199.8	202.5	101.3		503.6		109.2	109.2	612.8	*
	2			202.5	101.3		303.8			0.0	303.8	
	3				101.3		101.3			0.0	101.3	
Sep.	1				101.3		101.3		225.9	225.9	327.1	
	2				101.3		101.3		225.9	225.9	327.1	
	3				101.3		101.3		225.9	225.9	327.1	
Oct.	1				101.3		101.3		225.9	225.9	327.1	
	2				101.3		101.3			0.0	101.3	
	3					391.5	391.5			0.0	391.5	
Nov.	1					391.5	391.5			0.0	391.5	
	2					391.5	391.5			0.0	391.5	
	3					391.5	391.5			0.0	391.5	
Dec.	1						0.0			0.0	0.0	
	2						0.0			0.0	0.0	
	3						0.0			0.0	0.0	

Note: LP: Land Preparation
TP: Transplanting
WD: Weeding
HV: Harvesting

Table FC-5 (3/3) Seasonal Labour Requirement under the Proposed Cropping Pattern in Hun Model Area
(Dry season 0 ha, Wet season 258 ha of lowland and 485 ha of upland rice)

(Unit: man/day)

Month	Season	Lowland Rice						Upland Rice			Total
		Nur.	LP	TP	WED	HV	Sub-total	LP,TP	WD,HV	Sub-total	
Jan.	1						0			0.0	0.0
	2						0			0.0	0.0
	3						0			0.0	0.0
Feb.	1						0			0.0	0.0
	2						0			0.0	0.0
	3						0			0.0	0.0
Mar.	1						0	591.7		591.7	591.7
	2						0	591.7		591.7	591.7
	3						0	591.7		591.7	591.7
Apr.	1						0	591.7		591.7	591.7
	2						0	591.7		591.7	591.7
	3						0	137.4		137.4	137.4
May	1						0	137.4		137.4	137.4
	2						0	137.4		137.4	137.4
	3						0	137.4		137.4	137.4
Jun.	1						0	137.4	381.1	518.5	518.5
	2	81.4					81.43	137.4	381.1	518.5	599.9
	3	81.4	210.9				292.3		381.1	381.1	673.4
Jul.	1	81.4	210.9				292.3		381.1	381.1	673.4
	2	81.4	210.9	213.8			506.1		381.1	381.1	887.2
	3		210.9	213.8			424.7		381.1	381.1	805.7
Aug.	1		210.9	213.8	106.9		531.5		381.1	381.1	912.6 *
	2			213.8	106.9		320.6			0.0	320.6
	3				106.9		106.9			0.0	106.9
Sep.	1				106.9		106.9		666.9	666.9	773.8
	2				106.9		106.9		666.9	666.9	773.8
	3				106.9		106.9		666.9	666.9	773.8
Oct.	1				106.9		106.9		666.9	666.9	773.8
	2				106.9		106.9			0.0	106.9
	3						0			0.0	0.0
Nov.	1					413.3	413.3			0.0	413.3
	2					413.3	413.3			0.0	413.3
	3					413.3	413.3			0.0	413.3
Dec.	1					413.3	413.3			0.0	413.3
	2						0			0.0	0.0
	3						0			0.0	0.0

Note: LP: Land Preparation
TP: Transplanting
WD: Weeding
HV: Harvesting

Figure

Xai

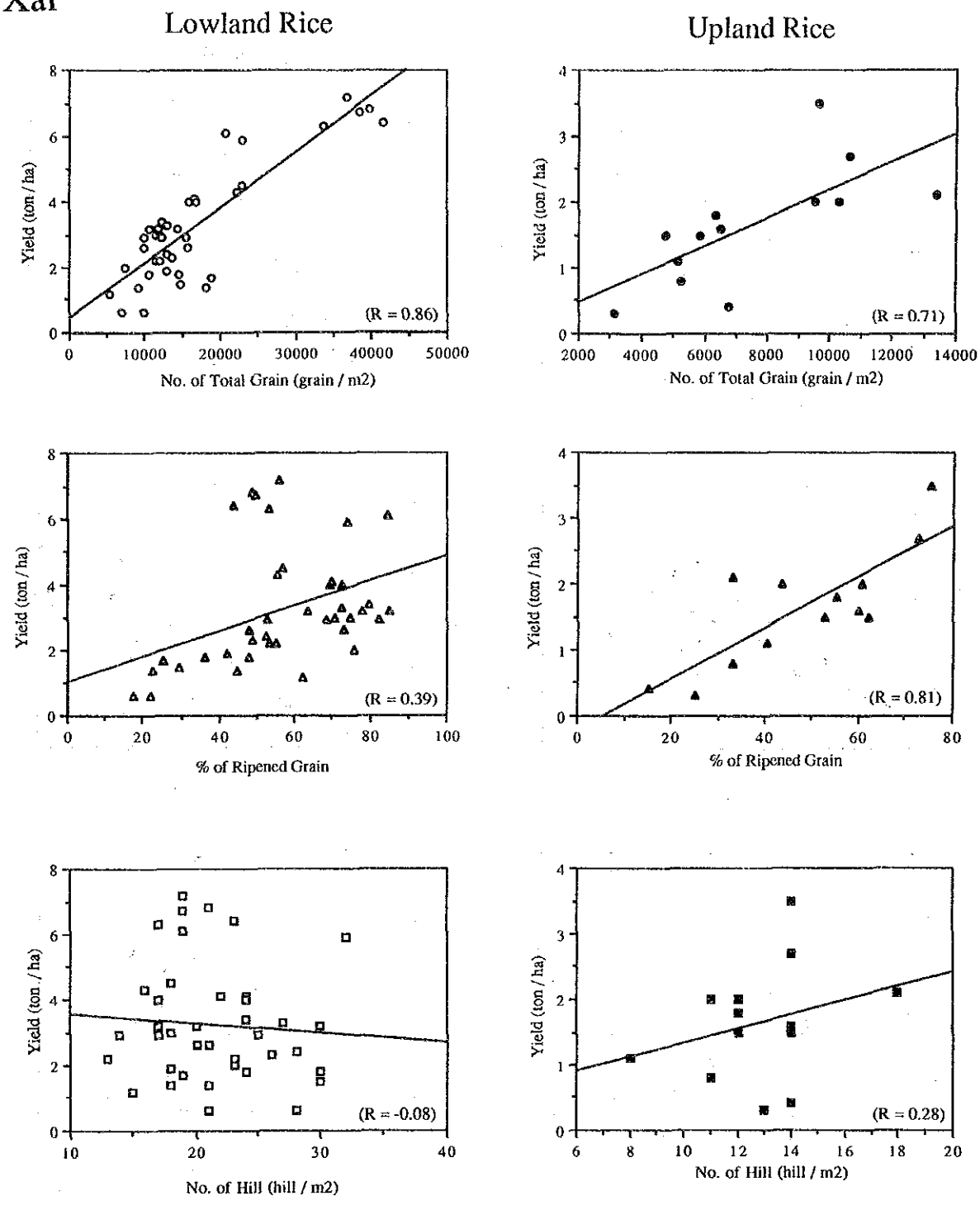

Fig. FC - 1(1/3) Correlation between Unit Yield and Yield Component

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Beng

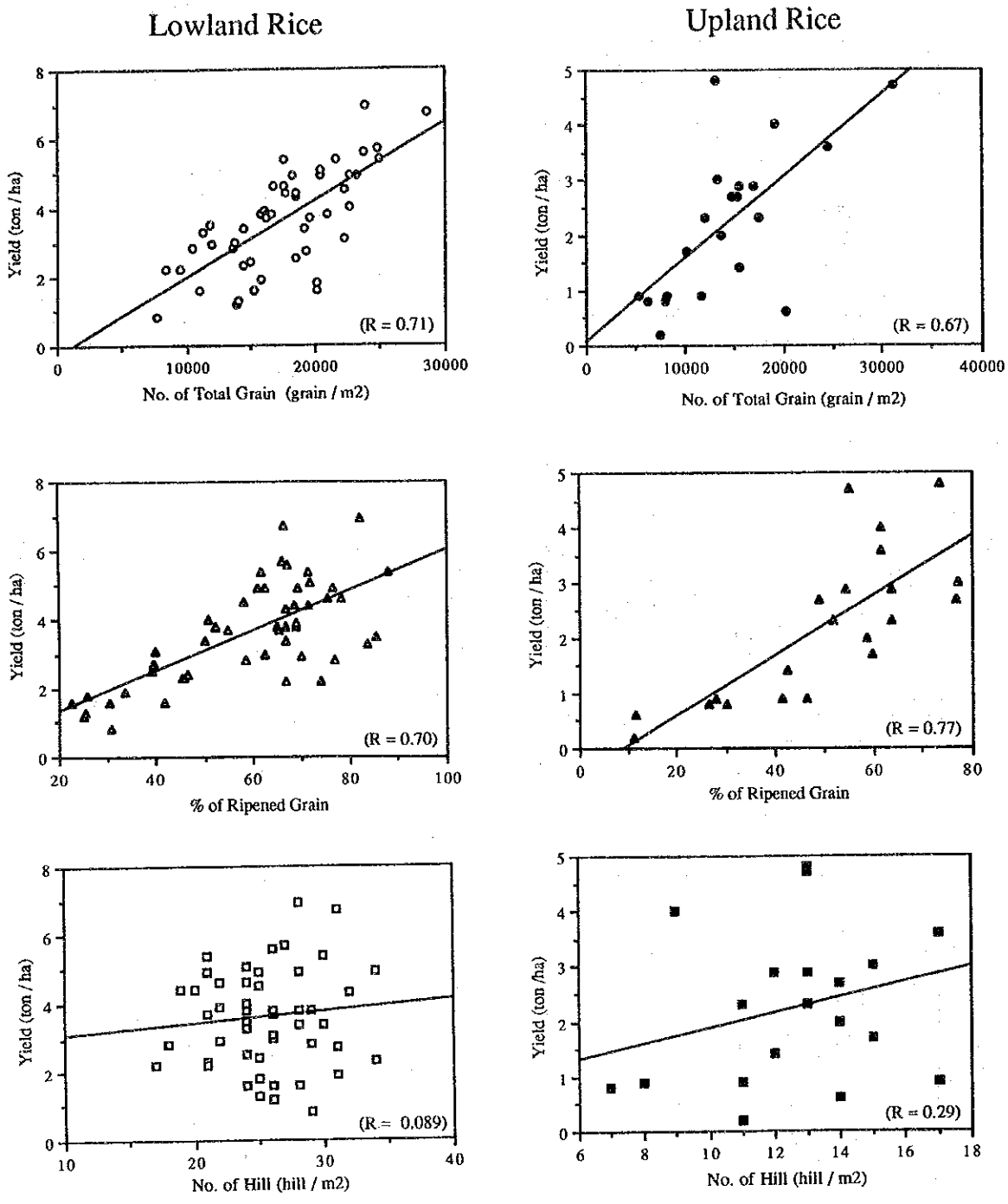

Fig. FC - 1(2/3) Correlation between Unit Yield and Yield Component

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
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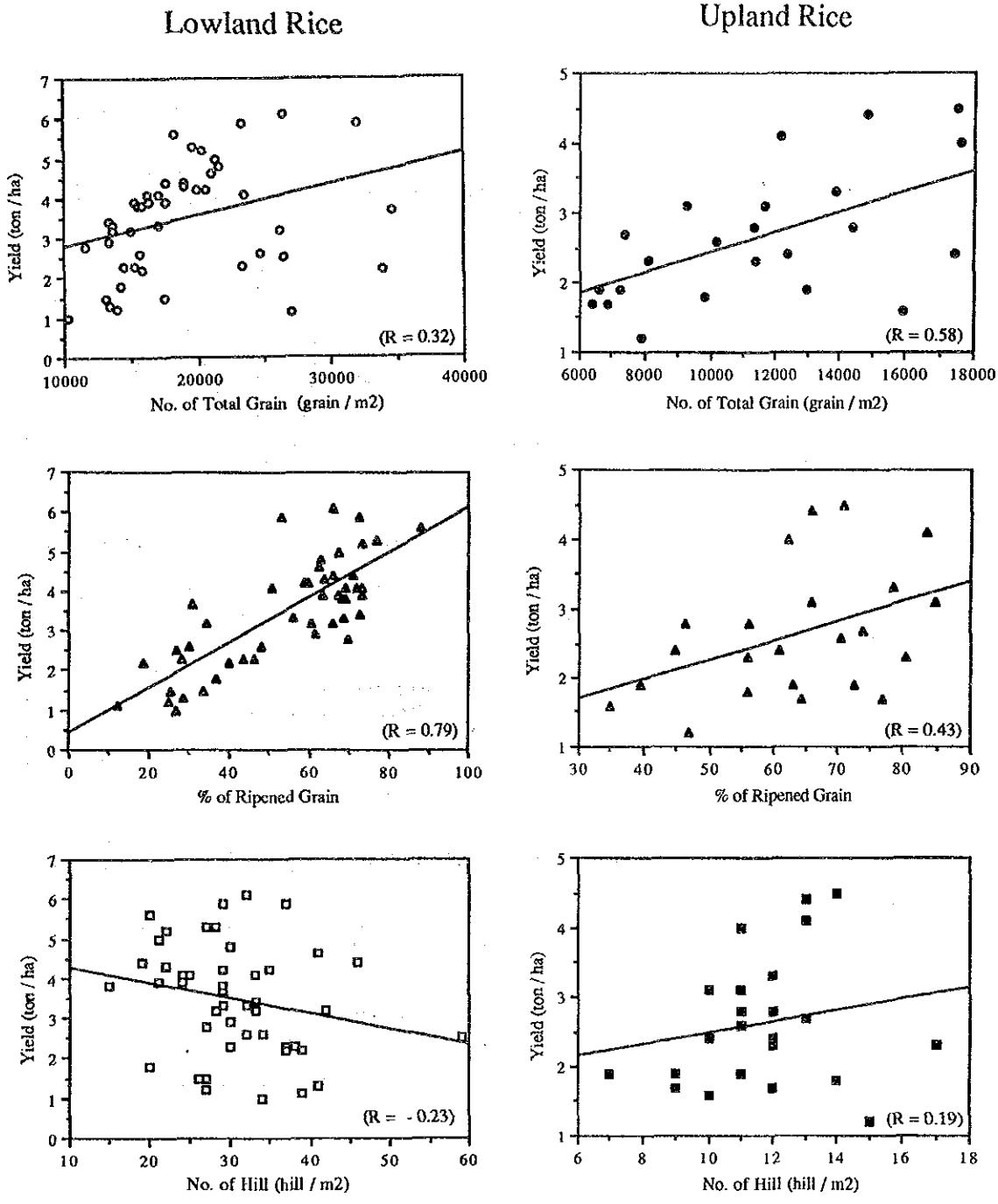

Fig. FC - 1(3/3) Correlation between Unit Yield and Yield Component

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
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(Unit: ha in net)

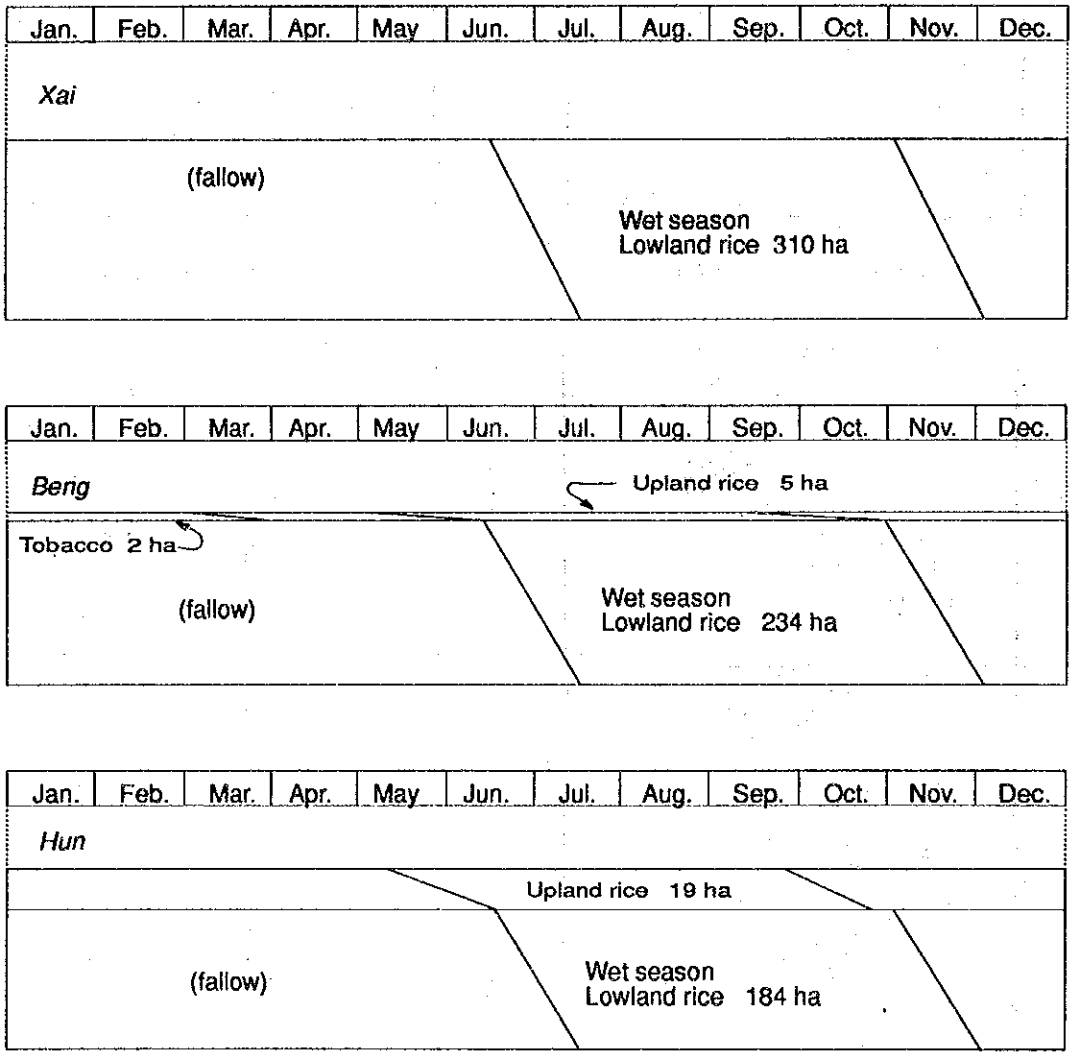

Fig. FC-2 Present Cropping Pattern in the Model Scheme Area

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(Unit: ha in net)

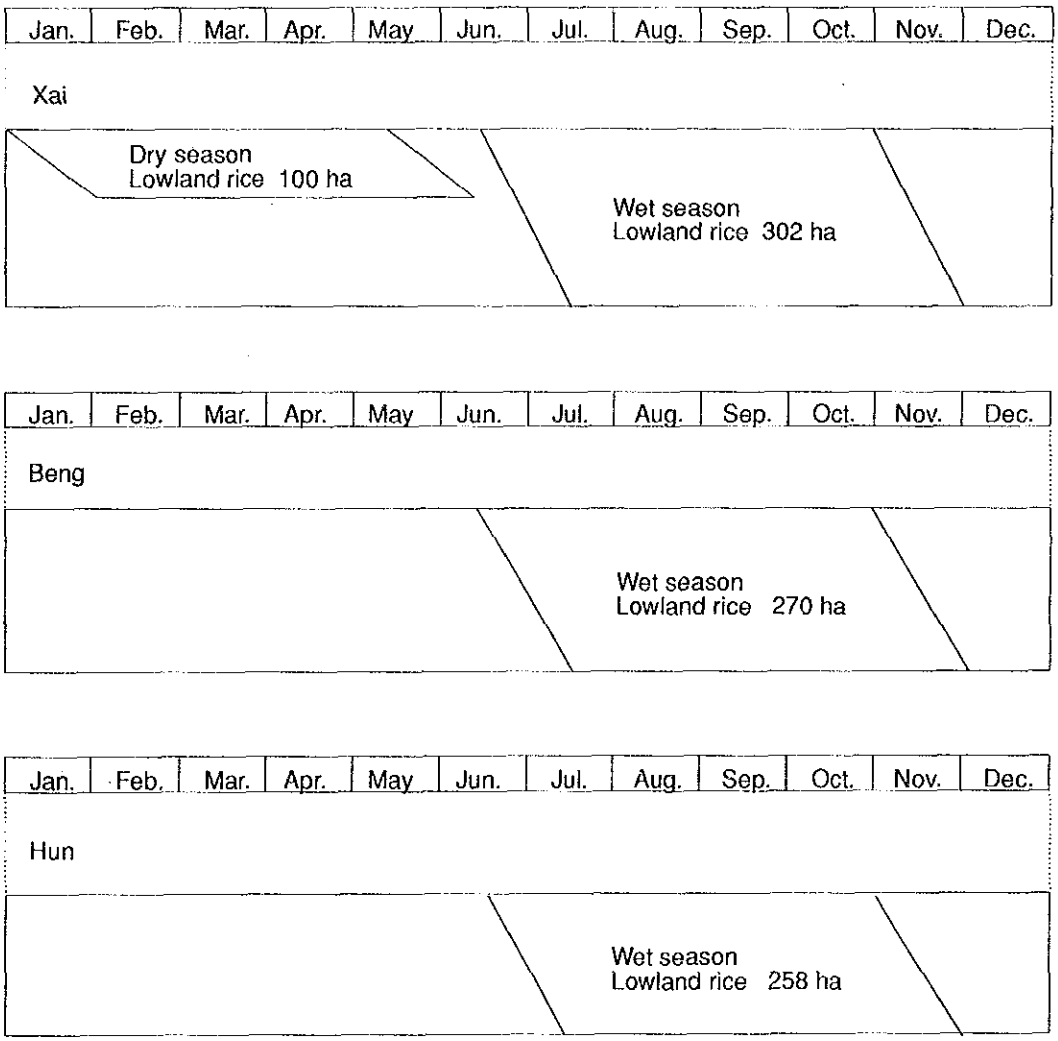

Fig. FC-3 Proposed Cropping Pattern in the Model Scheme Area

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
AGRICULTURAL DEVELOPMENT PROJECT TO CONTROL SLASH AND BURN CULTIVATION IN OUDOMXAY PROVINCE
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ANNEX-FD
IRRIGATION

ANNEX-FD IRRIGATION

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1. INTRODUCTION

This ANNEX presents all the results of field investigations and studies carried out for preparation of feasibility-level design of the proposed irrigation and drainage development in each of the three model areas in Xai, Beng and Hun districts which are selected in the Master Plan Study. The results of field investigations and studies include present conditions of existing irrigation system, irrigation and drainage requirements, development concept, and feasibility-level design of the required facilities in each model area.

2. PRESENT CONDITION

2.1 Existing Irrigation System

Lowland in each model area is utilized for lowland rice cultivation to a possible maximum extent at present. The lowland ride field is being irrigated only in the wet season because of limited water resources, using the weirs and canals constructed mostly by farmers themselves.

Existing irrigation systems in the model areas are small/medium-scale systems and have comparatively larger command area than other irrigation systems in Oudomxay Province. Most of the weirs constructed by farmers themselves are of brushwood type made by stone, wood and soil. There exist four concrete weirs in Hun model area under the financial assistance of the Province/District or Quaker Service (NGO). Since the brushwood weir has much water losses and is easily washed away by a flood every year, it requires much labor force to repair it every year. Even if concrete weir is constructed by the Province/District or Quaker, the canal network is not aligned properly because it is constructed by farmers themselves without any assistance from the Province/District. To utilize limited water resources, it is needed to replace the brushwood weirs into permanent one and to construct well designed canal network.

The existing irrigation systems related to each model area are shown in Table FD-1.

2.1.1 Xai Model Area

Lowland rice field in Xai model area is estimated at 310 ha in net. To irrigate the rice field, there exist two irrigation systems on the Nam Mao which command 197 ha in total. One is irrigating rice field on the left bank of the Nam Mao, and the other is supplying irrigation water to rice field on the right bank area. The intake weirs of both systems are of brushwood type constructed by farmers groups, using bamboo, wood, stone and clay soil. The main canals are also constructed by farmers groups. In the wet season in 1992, 165 ha of rice field were irrigated, and beneficiaries of the two irrigation systems are 193 families of seven Lao Loum villages. The details are shown in Table FD-2. The remaining 145 ha of rice field are irrigated by using stream water from the adjacent mountain. The two irrigation systems could be integrated into one system by constructing a permanent weir on the Nam Mao near Houaykhoum village. In addition, the whole lowland rice field of 310 ha in this model area could be irrigated by such a permanent weir and new canal network.

In the mild slope area behind the Oudomxay airport, Ban Nakang, various kinds of vegetable are planted using excessive water from the Houay Hiphi river which is a source of water supply to Xai town. The farmer constructs small ponds and practices irrigation by bucket using ponded water to this upland crop field. This type of agriculture can be expanded to the adjacent mild slope area using the excessive water from the Houay Phuk river.

2.1.2 Beng Model Area

The existing lowland rice field in Beng model area is estimated at 234 ha, most of which is irrigated by five existing irrigation systems. The diversion weirs of these systems are of brushwood type constructed by farmers groups on the Nam Hao, a tributary of the Nam Beng. Two main canals are also constructed by farmers groups with an assistance from the provincial office. One canal goes towards north, and the other runs to the south along the National Road No.2. Total irrigation area by these existing systems in the wet season is estimated at 221 ha, 188 ha by two irrigation systems and the remaining 33 ha by other three systems. The beneficiary of the five irrigation systems is six Lao Loum villages and one Lao Theung village. Topographically, the whole rice field in this model area could be irrigated by one weir to be constructed on the Nam Hao, instead of five existing weirs. At the same time, the existing main canals should be improved, together with the construction of new distribution network.

2.1.3 Hun Model Area

The existing irrigation systems related to Hun model area are six with two water sources, the Nam Kham and the Nam Ngat, of which four systems already have concrete permanent weir constructed by farmers groups with the financial assistance from the provincial office (one weir), district office (two weirs) and Lao Quaker service (one weir). These permanent weirs are maintained in good condition, except for some parts for which small repair works will be required. The remaining two weirs are of brushwood type and should be replaced by new permanent weir. Total irrigation area by these existing systems in the wet season is estimated at 267 ha. Irrigation canal networks are also constructed by farmers groups. However, the alignment and design of canals are still primitive to meet the requirements for effective use of available river water in both wet and dry seasons. In fact, only 164 ha of rice field received irrigation water in the wet season of 1992. The beneficiary of the six irrigation systems are farmers in 11 villages, consisting of five Lao Loum, four Lao Theung, one Lao Sung and one mixed. Because of a luck of irrigation water in this model area, conflict of water distribution happens sometimes.

2.2 Irrigation Practice

Most of the rice fields in the study area are irrigated by the canals to which the water is supplied by the diversion weirs on the tributaries of the Nam Beng and Nam Ko. There is no pump irrigation system in the study area. The upland rice field in the shifting cultivation area depends on rain only. It is found that some farmers practice irrigation to their small area of vegetable fields by a bucket bringing water from adjacent pond or canal. The irrigation to the rice field is practiced only in the rainy season and is started when the water is sufficient to take from the river. Since the starting time of irrigation depends largely on the climatic condition, it is difficult to follow the planned cropping calender. As no intake gate is installed at the head of the canal, the intake discharge can not be controlled.

2.3 O & M of Existing Irrigation System

Existing irrigation systems in the model areas are managed by farmers themselves. Therefore, O&M cost is a burden on a user of the system. Most of the existing irrigation systems have a water user's committee which is organized by the villages concerned. This committee consists normally of a village chief and/or a person in charge of water use who is elected from each village. Committee member inspects the condition of the weirs and canals and makes a maintenance plan of it. The committee holds a meeting for O&M of the system at the beginning of the rainy season to decide a contribution from each village. In the case that cost of maintenance of the weir or new construction of the weir cannot be covered by farmers, committee requests fund to the district office. In the case of Xai district, district office holds the meeting to settle conflicts among villages.

All of the farmers who receive the service of the irrigation system have to participate in the maintenance work, depending on the size of their own rice field. It is not authorized but there is traditional regulation of water use. It is still rare case to collect water charge.

These water user's committee has to be strengthened for O&M of new irrigation systems of the model area. New water users organization can easily be reorganized based on this water user's committee.

3. IRRIGATION WATER REQUIREMENT

3.1 General

Based on the proposed cropping pattern shown in Annex-FC, the irrigation water requirement is estimated for water balance study and preliminary design of irrigation system. Applying the FAO method mentioned in the FAO Irrigation and Drainage Paper No.24, the irrigation water requirement is estimated on a monthly basis using monthly climatic and rainfall data.

The irrigation water requirements for each crop are estimated by the following equation:

$$IR = (ETcrop + P + LP - ER) / IF$$

where,
- IR : Gross irrigation water requirement
- ETcrop : Crop water requirement
- P : Percolation loss in paddy field
- LP : Water requirement for land preparation
- ER : Effective rainfall
- IF : Irrigation efficiency

3.2 Crop Water Requirement

To account the crop characteristics on crop water requirement, crop coefficients (Kc) are presented to relate reference crop evapotranspiration (ETo) to crop evapotranspiration (ETcrop). According to the above FAO publication, the crop water requirement can be estimated by the following equation:

$$ETcrop = Kc \times ETo$$

where,
- ETcrop : Crop water requirement
- Kc : Crop coefficient
- ETo : Reference crop evapotranspiration

As mentioned in ANNEX-FC, the proposed cropping pattern consists of rice, onion and tobacco. Crop coefficients are derived from the FAO publication mentioned above and are tabulated for each crop as shown below:

	Crops	Days	Crop coefficient for 10 days							
Rice (wet season)	135	1.10	1.10	1.10	1.10	1.10	1.10	1.09	1.08
		1.05	1.02	0.99	0.96	0.93	0.92		
Rice (dry season)	135	1.10	1.10	1.10	1.10	1.10	1.12	1.17	1.22
		1.24	1.20	1.12	1.05	0.96	0.90		
Onion	100	0.48	0.52	0.57	0.67	0.78	0.94	1.00	0.95
		0.90	0.84						
Tobacco	115	0.30	0.40	0.52	0.70	0.92	1.08	1.10	1.10
		1.05	0.94	0.75	0.50				

The ETo is estimated by Modified Penman method using the monthly climatic data at Oudomxay meteorological station. The climatic data used for ETo estimation are shown in Table FD-3, and the estimated ETo is as follows:

(Unit: mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2.56	3.39	4.32	4.98	5.02	3.56	3.49	4.03	3.69	3.20	2.58	2.27

3.3 Effective Rainfall

A probable minimum rainfall with a 5-year return period, the rainfall with 80% probability in other word, is used for the estimation of the irrigation water requirement. The effective rainfall is estimated on a monthly basis by means of the "Effective Rainfall Chart" developed by RID, Thailand shown in Fig. FD-1. The estimated effective rainfall with 80% probability is as follows:

(Unit: mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
80 % rainfall	6.8	19.0	24.0	86.1	129.3	149.8	189.0	202.1	92.2	77.7	32.0	3.9	1011.8
Effective rainfall													
- Rice field	6	21	26	78	103	116	138	150	62	60	26	3	789
- Upland crop	4	12	16	50	66	74	87	93	49	47	21	3	522

3.4 Irrigation Efficiency

The irrigation loss consists of field application loss, operation loss and conveyance loss. The field application efficiency depends on the soil and the irrigation method as well as the irrigation skill of the farmers. The operation efficiency is affected by the skill of water management and operation of the control facilities. The factor affecting conveyance efficiency is mainly condition and materials of the canals.

Overall irrigation efficiency is assumed at 50% in rice field and 43% in upland as shown below:

	Rice field	Upland
1. Conveyance efficiency	90%	90%
2. Operation efficiency	80%	80%
3. Field application efficiency	70%	60%
Overall efficiency	50%	43%

3.5 Irrigation Water Requirements

The net irrigation water requirements for each crop are calculated according to the proposed cropping pattern by the crop water requirements adding other losses, if any, as mentioned in Section 3.1. To estimate the diversion water requirement and to determine the canal capacity, the gross irrigation water requirement has to be calculated by dividing net irrigation water requirement by overall irrigation efficiency. The conditions considered to estimate the irrigation water requirement are as follows:

(1) Percolation loss is assumed at 2 mm/day for paddy field.

(2) Initial water requirement of 150 mm for land preparation is considered for paddy field.

(3) The water requirement for nursery beds for rice which has an area of 1/20 of the main fields is assumed at 1.5 times the initial water requirement for the main fields.

The gross irrigation water requirements for wet season rice, dry season rice, onion and tobacco are presented in Table FD-4 and are summarized below:

(Unit: lit/sec/ha)

Crop	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rain season rice	-	-	-	-	-	0.00	0.33	0.36	0.89	0.68	0.28	-
Dry season rice	0.77	1.37	1.42	1.21	0.48	0.00	-	-	-	-	-	-
Onion	0.48	0.76	0.36	-	-	-	-	-	-	-	-	0.31
Tobacco	0.58	0.83	0.50	0.00	-	-	-	-	-	-	0.00	0.24

3.6 Water Balance Study

The water balance of a diversion water requirement and an available river runoff is studied to determine a proper size of irrigation development. According to the proposed

cropping pattern, the diversion water requirement for each model area is estimated by using the gross irrigation water requirements for each crop mentioned in Section 3.5. The results are that peak diversion water requirements are 0.269 m^3/sec for Xai model area, 0.240 m^3/sec for Beng model area, 0.180 m^3/sec for the Nam Ngat area and 0.051 m^3/sec for the Nam Kham area in Hun model area. These peak diversion water requirements will occur in September. The details are presented in Table FD-5. Also the diversion water requirements for the trial farms are estimated as shown in Table FD-5. The proposed cropping area to estimate the diversion water requirements is as shown below:

(Unit: ha)

Area	Wet Season		Dry Season		Water Source
	Net	Gross	Net	Gross	
Xai model area	302	(378)	125	(156)	Nam Mao
Beng model area	270	(338)	0	(0)	Nam Hao
Hun model area					
- Nam Ngat area	201	(252)	0	(0)	Nam Ngat
- Nam Kham area	57	(71)	0	(0)	Nam Kham
Trial farm					
- Rice	4	(5)	4	(5)	Nam Ko
- Sloped area	8	(10)	0.8	(1)	Houay Phuk

On the other hand, available river runoff is estimated at the intake site, taking into account the river maintenance flow of 1 lit/s/km^2. The catchment area at each of the proposed intake sites is as follows:

Unit: km^2

River	Catchment area at intake site
Nam Mao	200
Houay Phuk	1
Nam Hao	69
Nam Ngat	47
Nam Kham	55

Based on the above conditions, the water balance study of available river runoff and diversion water requirement is carried out as shown in Table FD-6. The results of the water balance study show that all of the rivers can fully irrigate the proposed cropping area in the wet season. However, the Nam Mao only can irrigate 125 ha in net in the dry season.

4. DRAINAGE REQUIREMENT

4.1 General

Each model area consists of rice field and is surrounded by upland field. Since drainage characteristics of these lands are different particularly in runoff time and runoff discharge, the drainage requirements for rice field and that for upland field are separately estimated. In order to decide a capacity of drainage structures, storm runoff is estimated by the daily maximum rainfall with a 10-year return period as design rainfall.

4.2 Drainage Requirement for Rice Field

Based on the rainfall records at Oudomxay and Luang Prabang as mentioned in ANNEX-MA, the probable maximum daily rainfall is estimated by means of Gumbel method as shown below:

Return period	1/5	1/10	1/20	1/30	1/40	1/50
Daily maximum rainfall (mm)	127.6	154.4	180.1	194.9	205.3	213.3

The drainage requirement for the rice field is estimated at 3.1 lit/sec/ha by the following equation and conditions:

Conditions

1) Design rainfall is 154 mm/day obtained from above table.
2) Effective water depth in rice field is assumed at 150 mm.
3) Standing water depth in rice field is assumed at 50 mm.
4) Excess rainfall to be drained from rice field with in 48 hours.

Equation

$Q = q \times A$

$q = RE_{24} \times 10\ m^2 / (3{,}600\ sec \times 48\ hours) = 3.1\ lit/sec/ha$

$RE_{24} = R_{24} - (D1 - D2) = 154.4 - (150 - 50) = 54.4\ mm$

where,
- Q : Design drainage requirement (lit/sec)
- q : Unit drainage requirement per ha (lit/sec/ha)
- A : Drainage area (ha)
- R_{24} : Probable maximum daily rainfall (mm/day)
- RE_{24} : Excess rainfall to be drained (mm)
- D1 : Effective water depth in the paddy field (mm)
- D2 : Standing water depth in the paddy field (mm)

4.3 Drainage Requirement for Upland Field

The drainage requirement for upland field is estimated based on the design rainfall, using the McMath formula derived from "Drainage Manual" of U.S. Department of the Interior.

$$Q = 2.3 \times C \times i \times S^{1/5} \times A^{4/5}$$

where, Q : Flood discharge (lit/sec)
C : Coefficient representing the watershed characteristics
i : Hourly rainfall (mm/hr)
S : Fall of main channel between the farthest point and the point of concentration
A : Catchment area (ha)

Hourly rainfall is estimated from daily rainfall by the following equation:

$$i = R24 \times (1/24)^{1/3} = 154.4 \times 0.347 = 53.5 \text{ mm/hr}$$

where, i : Hourly rainfall (mm/hr)
R24 : Daily rainfall (mm/day)

Applying the coefficient "C" of 0.32 for the study area, and hourly rainfall of 53.5 mm/hr, the drainage requirement can be expressed by the following equation:

$$Q = 39.4 \times S^{1/5} \times A^{4/5} \quad \text{(lit/sec)}$$

5. DEVELOPMENT PLAN

5.1 Basic Concept

There exists existing irrigation systems mostly with primitive irrigation facilities for each model area. As a result of the water balance study mentioned in Section 3.6, available water resource could irrigate the proposed cropping area fully in the wet season. In the dry season, however, irrigation water is available to irrigate only part of the area or almost nil. Therefore, the main purpose of the irrigation development for the model areas will be a supplemental irrigation for the cultivation of the wet season rice. The basic concept of the irrigation development is as follows:

(1) The function of the canal is separated into irrigation purpose and drainage purpose.

(2) The existing weir, brushwood type, will be replaced by concrete weir.

(3) Main irrigation canal will be lined with wet stone masonry.

(4) Secondary irrigation canal which covers 10 to 30 ha in net will be newly constructed. The on-farm canal will be constructed by farmers groups themselves with technical assistance of the province.

(5) O&M road will be provided along main irrigation canal in general.

(6) Drainage canal will be provided to drain excess water from rice field and to drain water from outside the model area to protect the irrigation facilities from flood damage.

The development plan for each model area is explained in the following section and is summarized in Table FD-7 and Fig. FD-2 to FD-4.

5.2 Xai Model Area

In order to irrigate the whole 302 ha in net (378 ha in gross) of existing lowland rice field in this model area, a new concrete weir will be constructed on the Nam Mao, integrating the two existing brushwood weirs into one. The new weir is located near Houaykhum village, about 4.5 km south from the Xai town center. The crest length and height

of the weir would be 60 m and 4.2 m, respectively. In the dry season, it will be able to irrigate 125 ha of rice field utilizing the natural runoff of the Nam Mao.

Two main irrigation canals will be constructed to irrigate rice field on both banks of the Nam Mao. The right main canal with a total length of 4.6 km will run along the foot of the hill commanding 194 ha of rice field, and the left main canal with a total length of 2.3 km will run through Nasao village to irrigate 108 ha of rice field.

It has to be noted that there is an expansion plan of the existing Oudomxay Airport. This plan is that the existing runway of 1,200 x 70 m will be expanded to 1,500 x 80 m with 40 m width of pavement. For the demarcation of the irrigation development area, therefore, this plan should be considered.

5.3 Beng Model Area

Three alternatives are considered for the study on the most suitable irrigation development in this model area.

Alternative-1: a new concrete weir will be constructed on the Nam Beng to irrigate 149 ha in net of existing rice field, the northern part of the model area. The crest length and height of the weir would be 60 m and 3 m, respectively. In order to irrigate 149 ha of rice field, a headrace with a total length of 3 km will be required topographically, and a main canal, 2.5 km in length, will be newly constructed along the National Road No.2.

Alternative-2: a new concrete weir will be constructed on the Nam Hao, integrating the two existing brushwood weirs into one. The new weir will be located at the upstream end of the fan of the Nam Hao. The crest length and height of the weir would be 40 m and 1.6 m, respectively. The rice field of 270 ha in total could be irrigated by two main canals. Existing right canal will be improved into the right main canal with a total length of 5.3 km commanding 167 ha, and existing left canal will be improved into the left main canal with a total length of 4.1 km commanding 103 ha. The river improvement will be required for a total length of 0.9 km of the Nam Hao to control a flood.

Alternative-3: a small-scale reservoir will be constructed on the Nam Hao to irrigate 237 ha of rice field both in the wet and dry season.

In the case of Alternative-1, the weir on the Nam Beng will be larger than that on the Nam Hao in Alternative-2, and a headrace with a total length of 3 km will also be required.

The command area will be limited to northern part of the model area topographically. Since the headrace will run through the existing rice field which is located outside the command area, in addition, farmers and the district office oppose the plan of Alternative-1. In the case of Alternative-3, storage capacity of the reservoir will be 2,630,000 m^3 to irrigate the whole rice field in both the wet and dry seasons (see Table FD-8). The dam site is located about 500 m upstream from the National Road No.2, and the crest length and height of the dam would be 250 m and 17 m, respectively. Since the existing rice field of about 15 ha will be submerged by the dam and the construction cost of the dam would be 6.6 million US dollars, this dam construction is not recommended at the short-term development stage. In the case of Alternative-2, the runoff of the Nam Hao is insufficient for the rice cultivation in the dry season. However, all the rice fields of the model area could be fully irrigated in the wet season and the existing two canals could be improved. As a result, a plan of Alternative-2 is recommended at the short-term development stage for this model area.

5.4 Hun Model Area

Existing three irrigation systems will be improved with concrete weirs and new canal networks. Those are the Nam Kham No.1 system (mainly Nakham-tai village), the Nam Ngat No.1 system (mainly Na village) and Nam Ngat No.4 system (mainly Phonsavath village). Two existing brushwood weirs of Nam Kham No.1 system on the Nam Kham and of Nam Ngat No.1 system on the Nam Ngat will be replaced by concrete one. The crest length and height of the new Nam Kham No.1 weir would be 40 m and 2.1 m, and those of the Nam Ngat No.1 weir would be 22 m and 1.8 m, respectively. Existing two irrigation systems of Nam Ngat No.2 and No.3 (mainly Somxai village) will be integrated to Nam Ngat No.2 system with minor repair of existing concrete weir and new canal network. The irrigation area of each canal system would be as follows:

Canal system	Water source	Irrigation area in net (ha)
Nam Ngat No.1	Nam Ngat	70
Nam Ngat No.2	Nam Ngat	74
Nam Ngat No.4	Nam Ngat	57
Nam Kham No.1	Nam Kham	57
Total		258

Since the runoff from the Nam Kham and Nam Ngat is very limited in the dry season, possibility of constructing a small reservoir is studied to utilize the runoff effectively for increase in irrigation area in the dry season. The dam site is located on the Nam Kham in between Nakham-nua and Somphon village as shown in Fig. FD-5. Since the maximum height of the dam is limited to 12 m to avoid submergence of Somphon village, the maximum storage capacity is estimated at 348,000 m^3. The dam will be of earth-fill type with 160 m of

crest length, 12 m of dam height and dam volume of 31,300 m^3. Even if the dam were constructed the increase in irrigation area in the dry season will be 18 ha only. In addition, there exists limestone area near the dam site for which detailed investigation of conditions of the foundation is required. As a result, this dam construction is not recommended at the short-term development stage because of very small effect by the dam construction and lack of detailed information on the dam foundation.

6. DESIGN AT FEASIBILITY STUDY LEVEL

6.1 Irrigation Facilities

6.1.1 Diversion Facility

(1) Location of Weir

In the case of Xai model area, the existing two brushwood weirs will be integrated into one concrete weir. In order to irrigate lowland rice field on both banks of the Nam Mao, the proposed weir is located at 80 m downstream from the confluence with the Houay Khum river near the Houaykhum village, about 4.5 km south from Xai town center. Maximum height of the weir is limited by the flood water level at the upstream side the weir to EL 297.70 to avoid submergence of the houses in Houaykhum village at flood times.

The proposed weir on the Nam Hao in Beng model area is located at the upstream end of the fan of the Nam Hao, about 2.6 km upstream from the National Road No.2, to irrigate all the existing rice field. The exposed rock is found at the right bank of the Nam Hao at the weir site. The river course is straight and stable at the weir site.

In the case of Hun model area, each of the existing two brushwood weirs will be replaced by concrete one. Nam Ngat No.1 weir will be located at the same place as the existing weir, about 5 km upstream from the confluence with the Nam Kham. Nam Kham No.1 weir will be constructed 50 m upstream from the existing brushwood weir that is located near Nakham-tai village, since the existing weir is located on the curve of the Nam Kham.

(2) Design of Weir

The proposed weirs are of fixed type made of concrete. The slide gate type of scouring sluices are provided for each weir to flush sediments away that will be deposited in front of the intake. As mentioned in Annex-MA, the peak flood discharge of 40-year return period is estimated based on the specific runoff of 2.7 $m^3/sec/km^2$ for Xai and Beng areas and

2.4 $m^3/sec/km^2$ for Hun area. The catchment areas and the design flood discharges for each weir are tabulated as follows:

Mode Area	Weir	Catchment Area (km^2)	Specific Runoff ($m^3/sec/km^2$)	Design Flood Discharge (m^3/sec)
Xai	Tham Nhuang	200	2.7	540
Beng	Nam Hao	69	2.7	186
Hun	Nam Ngat No.1	47	2.4	113
	Nam Kham No.1	55	2.4	132

The crest length of the weirs is determined by the following equation:

$$B = Q / (C \times H^{3/2})$$

where, B : Crest length (m)
Q : Flood discharge (m^3/s)
C : Discharge coefficient (C = 1.70)
H : Overflow depth (m)

The length of downstream apron is determined by Bligh's method as shown below:

$$L1 = 0.6 \times C \times D^{1/2}$$

where, L1 : Length of downstream apron (m)
C : Bligh's C (assumed at 9)
D : Height of weir from the end of apron

The length of downstream riprap is determined by the following equation:

$$L2 = L - L1$$
$$L = 0.67 \times C \times (Ha \times q)^{1/2} \times f$$

where, L2 : Length of downstream riprap (m)
L : Total length of downstream protection (m)
C : Bligh's C (assumed at 9)
Ha : Height from low water level at downstream to the crest
q : Design flood discharge per unit length of the crest ($m^3/s/m$)
f : Safety factor (1.0 for fixed weir)

(3) Design Results

The principal features of the weir for each model area are summarized as follows:

	Xai Tham Nhuang	Beng Nam Hao	Hun Nam Ngat No.1	Hun Nam Kham No.1
Fixed weir				
- Crest elevation (m)	EL 294.60	EL 324.60	EL 337.80	EL 322.10
- Crest length (m)	60	40	22	40
- Height of weir (m)	4.2	1.6	1.8	2.1
Apron and riprap				
- Length of apron (m)	12.0	7.0	7.5	8.0
- Length of riprap (m)	23.5	9.0	10.0	8.0
Scouring sluice				
- Gate size & nos. (m)	2.0 x 2.3 x 2	1.7 x 1.7 x 1	1.5 x 1.7 x 1	1.7 x 1.7 x 1
Intake				
- Intake water level (m)	EL 294.50	EL 324.50	EL 337.70	EL 322.00

Note: The elevation shown above is the tentative elevation used by JICA study team for mapping of the model areas.

6.1.2 Irrigation Canal

(1) Canal System

The irrigation canal systems of the model areas are composed of the main canals commanding 50 to 300 ha, depending on topography and service area, and the secondary canals. The secondary canal will be aligned for each irrigation block which covers 10 to 30 ha and is a unit of water management. The on-farm canal which serves 4 to 5 ha will be constructed by farmers themselves under technical guidance fro mthe project office. The main and secondary canals will be the open canals with trapezoidal section. O&M road will be provided basically along the main canal.

(2) Canal Lining

The main canal will be lined with wet masonry in order to minimize the width of the canal and maintenance works as well as to utilize limited water effectively. No lining will be provided for secondary canals.

(3) Design Criteria

The basic design criteria for irrigation canals are as follows:

a) Design discharge (Q) : 0.89 lit/sec/ha

b) Hydraulic formula : Manning formula

c) Allowable velocity

		Max.	Min.
- Wet masonry canal	:	1.5 m/sec	0.3 m/sec
- Unlined canal	:	0.6 m/sec	0.3 m/sec
- Concrete structure	:	2.0 m/sec	0.3 m/sec

d) Roughness coefficient (n)

- Wet masonry canal	:	0.025
- Unlined canal	:	0.030
- Concrete structure	:	0.015

e) Freeboard (Fb) : 0.20 m

f) Canal section

		Inside Slope	Outside Slope
- Wet masonry canal	:	1 : 0.5	1 : 1.5
- Unlined canal	:	1 : 1.0	1 : 1.0

(4) Design Results

The typical cross sections of the canals and O&M road are presented in Fig. FD-6. Irrigation flow diagrams for each model area are shown in Fig. FD-7 to FD-9. A list of irrigation canals is shown in Table FD-10 and is summarized below:

(Unit: m)

Canal	Xai model Area	Beng model Area	Hun model Area
Main canal	6,900	9,345	5,690
Secondary canal	12,855	13,915	13,560

6.1.3 Related Structures

Various kinds of structures such as turnout, culvert, drop, check and spillway are required to distribute the irrigation water properly and to convey it safely. All of them will be of reinforced concrete structure. A list of structures for each model area is presented in Table FD-11.

(1) Bifurcation Structure

Bifurcation structure will be provided on the main canal to divide water proportionally without any gate facilities.

(2) Turnout

Turnout will be provided to divert the certain amount of water from the main canal to the secondary canal. The turnout consists of an inlet equipped with a slide gate, a barrel made of precast concrete pipes and an outlet with a device of discharge measurement.

(3) Check

Check will be provided just downstream of the turnout on the main canal to control water level so as to be able to divert water to the secondary canal by the turnout. The check is equipped with wooden plank to control water level and has overflow portion to avoid overtopping the canal bank by accidental water rising.

(4) Culvert

Culvert will be provided at the point of road-crossing on the main and the secondary canals. The culvert is composed of wing-walls at both ends and a barrel made of precast concrete pipes.

(5) Aqueduct

Where the canals cross the natural streams, aqueduct will be provided. The aqueduct is composed of abutments at both sides of the stream, concrete flume and piers provided 8 m each of the flume. Since the canal discharge is less than 0.3 m^3/sec., there is no alternative of syphon considering the maintenance of it.

(6) Drop

Drops are required so as to reduce the velocity of flow within the allowable velocity. A vertical type drop will be provided at the place which is

determined in consideration of the cost of canal construction, balancing cut and fill.

(7) Spillway

Spillway will be provided on the main canal so as to avoid overtopping the canal bank caused by an accidental water rising. The spillway is of side-channel overflow type with a gated structure to drain canal water entirely.

(8) Division Box

Division Box will be provided on the secondary canal to distribute water to the on-farm canal which commands 4 - 5 ha.

6.2 Drainage Facilities

6.2.1 Drainage Canals

(1) Drainage System

The drainage canal for two purposes will be provided for the model area development. One is to drain excess water from the rice field and the other is to drain water from outside the model area to protect the irrigation facilities from flood damage. The design discharge for the area inside the model area is estimated as the drainage from the rice field. For the area outside the model area, the design discharge is estimated as the drainage from upland field. The drainage canals will be of the open canals with trapezoidal section.

(2) Design Criteria

The basic design criteria for drainage canals are as follows:

a) Design discharge (Q)

- Rice field : 3.1 lit/sec/ha
- Upland field : $Q = 39.4 \times s^{(1/5)} \times A^{(4/5)}$ (lit/sec)

where, s: Fall of main channel between the farthest point and the point of concentration
A: Catchment area (ha)

b) Hydraulic formula : Manning formula

c) Allowable velocity

		Max.	Min.
- Unlined canal	:	0.9 m/sec	0.3 m/sec
- Concrete structure	:	2.0 m/sec	0.3 m/sec

d) Roughness coefficient (n)

- Unlined canal	:	0.035
- Concrete structure	:	0.015

e) Freeboard (Fb) : Fb > 0

f) Inside slope of canal : 1 : 1.5

(3) Design Results

The typical cross section and dimensions of the drainage canal are presented in Fig. FD-6. Drainage flow diagrams for each model area are shown in Fig. FD-10 to FD-12. A list of drainage canals is shown in Table FD-12 and is summarized as below:

	Xai model Area	Beng model Area	Hun model Area
Total length (m)	7,000	6,345	9,160

6.2.2 Related Structures

The structures related to the drainage canals will be provided so as to drain excess water safely to the natural rivers. The related structures are drop, culvert and junction protection.

The drop is the same structure as that on the irrigation canals. The culvert will be provided at the road-crossing point and is of precast concrete pipe type. As for the junction protection, the riprap will be provided at the confluence of two or more drainage canals so as to protect from erosion. A list of structures for each model area is shown in Table FD-13.

6.2.3 River Improvement

In Beng model area, the land located at east side of National Road No.2 is part of flood plain of the Nam Hao. To settle the river course of the Nam Hao, therefore, improvement of the river section will be required for a length of 900 m along the river. The design discharge in the Nam Hao is estimated at 186 m^3/s of flood runoff with a 40-year return period. The proposed river bed width will be 15 m with an inside slope of 1:1.5 for the cross section in the improved portion.

Table

Table FD-1 Existing Irrigation Systems in the Model Areas

Model area	Water resource	Weir No.	Weir Type	Irrigable area	Const. year	Fund	Benefited village
Xai model area	Nam Mao	X1	Brushwood	- ha		Village	Nami, Nalao, Cheng, Houaykhoum, Nasao, Nale
(Tham Nhuang area)	Nam Mao	X2	Brushwood	- ha		Village	Nasao, Nale, Thin, Cheng
			Total	197 ha			
Beng model area	Nam Hao	B1	Brushwood	103 ha		Village	Nahouay, Bengkham, Phokeo, Pangdua
(Nam Hao area)	Nam Hao	B2	Brushwood	85 ha		Village	Bengluang, Thakat, Nahouay, Houayla
	Nam Hao	B3	Brushwood	10 ha		Village	Bengluang
	Nam Hao	B4	Brushwood	8 ha		Village	Nahouay
	Nam Hao	B5	Brushwood	15 ha		Village	Nahouay
			Total	221 ha			
Hun model area	Nam Kham	H1	Brushwood	40 ha		Village	Nakham-tai, Nakham-nua, Somphone, Mai, Na
(Nam Kham area)	Nam Kham	H2	Concrete	68 ha	1986	District	Nakhong, Nahom, Nafang, Phonsavath
	Nam Ngat	H3	Brushwood	20 ha		Village	Somxai, Na, Mai, Nakham-nua, Nakham-tai
	Nam Ngat	H4	Concrete	50 ha	1976	Province	Somxai, Na
	Nam Ngat	H5	Concrete	30 ha	1991	District	Somxai, Na
	Nam Ngat	H6	Concrete	59 ha	1989	Quaker	Phonsavath, Nongboadeng
			Total	267 ha			

Table FD-2 Beneficiaries of Existing Irrigation Systems in Xai Model Area

	Name of village	Ethnic group	Total families	Nam Mao No.1 Weir(u/s)		Nam Mao No.2 Weir(d/s)		Total			
				Family	Area(ha)	Family	Area(ha)	Family(A)		Area(B) (ha)	B/A (ha)
1	B.Cheng	LL	132	11	10.01	6	3.27	17	12.9%	13.28	0.78
2	B.Nami	LL	38	15	11.39			15	39.5%	11.39	0.76
3	B.Nalao	LL	135	5	3.82			5	3.7%	3.82	0.76
4	B.Houaykhoum	LL	97	40	29.67			40	41.2%	29.67	0.74
5	B.Nasao	LL	57	27	27.14	27	17.48	54	94.7%	44.62	0.83
6	B.Nale	LL	58	15	10.23	21	31.97	36	62.1%	42.20	1.17
7	B.Thin	LL	166			26	20.27	26	15.7%	20.27	0.78
	Total		683	113	92.26	80	72.99	193	28.3%	165.25	0.83

Table FD-3 ETO Modified Penman

Climatic station : Oudomxay
Latitude : 20° 41'N
Elevation : 550 m

Month	Mean Temperature (°C)	Relative Humidity (%)	Wind Speed (km/day)	Sunshine Hours (hours)	ETO (mm/day)
January	19.0	81	80	5.0	2.56
February	20.5	74	80	5.8	3.39
March	23.4	68	102	5.6	4.32
April	26.1	68	116	5.7	4.98
May	26.7	75	102	6.0	5.02
June	26.5	85	93	2.6	3.56
July	25.8	87	85	2.8	3.49
August	25.9	83	76	4.4	4.03
September	25.6	86	76	4.5	3.69
October	23.7	84	85	4.3	3.20
November	20.8	85	80	4.5	2.58
December	17.5	84	76	5.1	2.27

Note: Data of wind speed is of Luang Prabang.

Table FD-4 (1/4) Crop Water Requirement

Crop : Rice (Wet season, Future condition)

Irrigation efficiency : 50 %

	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. ETO	mm/day	2.6	3.4	4.3	5.0	5.0	3.6	3.5	4.0	3.7	3.2	2.6	2.3
2. Days	days	31	28	31	30	31	30	31	31	30	31	30	31
3. Cropping calender	days						15	31	31	30	28		
								15	31	30	31	28	
4. Crop coefficient(Kc)							1.10	1.10	1.09	1.04	0.95		
								1.10	1.10	1.07	0.99	0.93	
5. ETcrop							4.5	119.4	135.2	115.4	85.1		
								4.3	136.4	118.8	98.2	67.7	
Average	mm/month						2.2	61.8	135.8	117.1	91.7	33.9	
6. Puddling water	mm/month						75.0	75.0					
7. Percolation	mm/month						15.0	46.0	62.0	60.0	59.0	28.0	
8. Effective rainfall	mm/month	6.0	21.0	26.0	78.0	103.0	116.0	138.0	150.0	62.0	60.0	26.0	3.0
9. Net crop water req. (5)+(6)+(7)-(8)	mm/month						0.0	44.8	47.8	115.1	90.7	35.9	
10. Gross crop water req.	mm/month						0.0	89.7	95.6	230.2	181.3	71.7	
	l/s/ha						0.00	0.33	0.36	0.89	0.68	0.28	

Note:

1. ETO of Oudomxay Station is applied.
2. Rainfall data of Oudomxay station is applied.

Table FD-4 (2/4) Crop Water Requirement

Crop : Rice (dry season, future condition)

Irrigation efficiency : 50 %

	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. ETO	mm/day	2.6	3.4	4.3	5.0	5.0	3.6	3.5	4.0	3.7	3.2	2.6	2.3
2. Days	days	31	28	31	30	31	30	31	31	30	31	30	31
3. Cropping calender	days	31	28	31	30	15							
			28	31	30	31	15						
4. Crop coefficient(Kc)		1.10	1.10	1.21	1.12	0.93							
			1.10	1.10	1.21	1.12	0.93						
5. ETcrop		6.6	104.7	161.3	168.0	69.8							
			7.9	146.6	181.5	173.6	50.2						
Average	mm/month	3.3	56.3	154.0	174.8	121.7	25.1						
6. Puddling water	mm/month	75.0	75.0										
7. Percolation	mm/month	31.0	56.0	62.0	60.0	46.0	15.0						
8. Effective rainfall	mm/month	6.0	21.0	26.0	78.0	103.0	116.0	138.0	150.0	62.0	60.0	26.0	3.0
9. Net crop water req. (5)+(6)+(7)-(8)	mm/month	103.3	166.3	190.0	156.8	64.7	0.0						
10. Gross crop water req.	mm/month	206.6	332.6	379.9	313.5	129.4	0.0						
	l/s/ha	0.77	1.37	1.42	1.21	0.48	0.00						

Note:

1. ETO of Oudomxay Station is applied.
2. Rainfall data of Oudomxay station is applied.

Table FD-4 (3/4) Crop Water Requirement

Crop : Onion (dry season)

Irrigation efficiency : 43 %

	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. ETO	mm/day	2.6	3.4	4.3	5.0	5.0	3.6	3.5	4.0	3.7	3.2	2.6	2.3
2. Days	days	31	28	31	30	31	30	31	31	30	31	30	31
3. Cropping calender	days	31	28	10									31
		31	28	21									20
4. Crop coefficient(Kc)		0.80	0.95	0.84									0.75
		0.67	0.96	0.87									0.50
5. ETcrop		64.5	90.4	36.1									53.5
		54.0	91.4	78.6									23.0
Average	mm/month	59.2	90.9	57.3									38.2
6. Puddling water	mm/month												
7. Percolation	mm/month												
8. Effective rainfall	mm/month	4.0	12.0	16.0	50.0	66.0	74.0	87.0	93.0	49.0	47.0	21.0	3.0
9. Net crop water req. (5)+(6)+(7)-(8)	mm/month	55.2	78.9	41.3									35.2
10. Gross crop water req.	mm/month	128.5	183.5	96.1									81.9
	l/s/ha	0.48	0.76	0.36									0.31

Note:

1. ETO of Oudomxay Station is applied.
2. Rainfall data of Oudomxay station is applied.

Table FD-4 (4/4) Crop Water Requirement

Crop : Tobacco(dry season)

Irrigation efficiency : 43 %

	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. ETO	mm/day	2.6	3.4	4.3	5.0	5.0	3.6	3.5	4.0	3.7	3.2	2.6	2.3
2. Days	days	31	28	31	30	31	30	31	31	30	31	30	31
3. Cropping calender	days	31	28	10								15	31
		31	28	31	5								20
4. Crop coefficient(Kc)		1.06	0.97	0.62								0.33	0.62
		0.71	1.09	0.91	0.50								0.35
5. ETcrop		85.4	92.3	26.7								12.9	44.2
		57.2	103.8	121.3	12.5								16.1
Average	mm/month	71.3	98.1	74.0	6.3							6.4	30.2
6. Puddling water	mm/month												
7. Percolation	mm/month												
8. Effective rainfall	mm/month	4.0	12.0	16.0	50.0	66.0	74.0	87.0	93.0	49.0	47.0	21.0	3.0
9. Net crop water req. (5)+(6)+(7)-(8)	mm/month	67.3	86.1	58.0	0.0							0.0	27.2
10. Gross crop water req.	mm/month	156.6	200.1	134.8	0.0							0.0	63.1
	l/s/ha	0.58	0.83	0.50	0.00							0.00	0.24

Note:

1. ETO of Oudomxay Station is applied.
2. Rainfall data of Oudomxay station is applied.

Table FD-5 Diversion Water Requirement

Crops	Unit	Area in hectare Gross	Area in hectare Net	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Gross Crop Water Requirement															
Dry season rice	(l/s/ha)			0.77	1.37	1.42	1.21	0.48	0.00						
Wet season rice	(l/s/ha)								0.00	0.33	0.36	0.89	0.68	0.28	
Onion	(l/s/ha)			0.48	0.76	0.36									0.31
Tobacco	(l/s/ha)			0.58	0.83	0.50	0.00							0.00	0.24
Diversion Water Requirement															
(1) Xai Model Area															
Dry season rice	(m3/sec)	156	125	0.096	0.171	0.178	0.151	0.060	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wet season rice	(m3/sec)	378	302	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.109	0.269	0.205	0.085	0.000
Onion	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tobacco	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	(m3/sec)	534	427	0.096	0.171	0.178	0.151	0.060	0.000	0.100	0.109	0.269	0.205	0.085	0.000
(2) Beng Model Area															
Dry season rice	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wet season rice	(m3/sec)	338	270	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.097	0.240	0.184	0.076	0.000
Onion	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tobacco	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	(m3/sec)	338	270	0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.097	0.240	0.184	0.076	0.000
(3) Hun Model Area (Nam Ngat Area)															
Dry season rice	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wet season rice	(m3/sec)	252	202	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.073	0.180	0.137	0.057	0.000
Onion	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tobacco	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	(m3/sec)	252	202	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.073	0.180	0.137	0.057	0.000
(Nam Kham Area)															
Dry season rice	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wet season rice	(m3/sec)	71	57	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.021	0.051	0.039	0.016	0.000
Onion	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tobacco	(m3/sec)	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	(m3/sec)	71	57	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.021	0.051	0.039	0.016	0.000
(4) Trial Farm (rice)															
Dry season rice	(m3/sec)	5	4	0.003	0.005	0.006	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wet season rice	(m3/sec)	5	4	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.004	0.003	0.001	0.000
Total	(m3/sec)	10	8	0.003	0.005	0.006	0.005	0.002	0.000	0.001	0.001	0.004	0.003	0.001	0.000
(5) Trial Farm (sloped area)															
Upland rice (RS)	(m3/sec)	10	8	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.007	0.005	0.002	0.000
Upland crops (DS)	(m3/sec)	1	0.8	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	(m3/sec)	11	8.8	0.000	0.001	0.000	0.000	0.000	0.000	0.003	0.003	0.007	0.005	0.002	0.000

Table FD-6 Water Balance of Potential Water Resource and Irrigation Requirement

Item	Unit	Area (km2)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Unit Runoff														
Category 1	(m3/s/km2)		0.0022	0.0019	0.0019	0.0055	0.0095	0.0134	0.0171	0.0200	0.0166	0.0129	0.0089	0.0039
Category 2	(m3/s/km2)		0.0006	0.0005	0.0006	0.0012	0.0027	0.0040	0.0050	0.0061	0.0061	0.0040	0.0031	0.0014
Category 3	(m3/s/km2)		0.0012	0.0009	0.0011	0.0024	0.0053	0.0081	0.0101	0.0122	0.0121	0.0081	0.0061	0.0028
Water Balance														
(1) Xai Model Area														
= Nam Mao (Category 1)														
1.Runoff	(m3/sec)		0.440	0.380	0.380	1.100	1.900	2.680	3.420	4.000	3.320	2.580	1.780	0.780
Catchment area		200												
2.Maintenance flow	(m3/sec)		0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
1.0 lit/s/km2		200												
3.Available runoff	(m3/sec)		0.240	0.180	0.180	0.900	1.700	2.480	3.220	3.800	3.120	2.380	1.580	0.580
4.Diversion req.	(m3/sec)		0.096	0.171	0.178	0.151	0.060	0.000	0.100	0.109	0.269	0.205	0.085	0.000
5.Balance	(m3/sec)		0.144	0.009	0.003	0.749	1.640	2.480	3.120	3.691	2.851	2.175	1.495	0.580
= Houay Phuk (Category 1)														
1.Runoff	(m3/sec)		0.002	0.002	0.002	0.006	0.010	0.013	0.017	0.020	0.017	0.013	0.009	0.004
Catchment area		1												
2.Maintenance flow	(m3/sec)		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
1.0 lit/s/km2		1												
3.Available runoff	(m3/sec)		0.001	0.001	0.001	0.005	0.009	0.012	0.016	0.019	0.016	0.012	0.008	0.003
4.Diversion req.	(m3/sec)		0.000	0.001	0.000	0.000	0.000	0.000	0.003	0.003	0.007	0.005	0.002	0.000
5.Balance	(m3/sec)		0.001	0.000	0.001	0.005	0.009	0.012	0.013	0.016	0.008	0.006	0.006	0.003
(2) Beng Model Area														
= Nam Hao (Category 3)														
1.Runoff	(m3/sec)		0.083	0.062	0.076	0.166	0.366	0.559	0.697	0.842	0.835	0.559	0.421	0.193
Catchment area		69												
2.Maintenance flow	(m3/sec)		0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
1.0 lit/s/km2		69												
3.Available runoff	(m3/sec)		0.014	-0.007	0.007	0.097	0.297	0.490	0.628	0.773	0.766	0.490	0.352	0.124
4.Diversion req.	(m3/sec)		0.000	0.000	0.000	0.000	0.000	0.000	0.089	0.097	0.240	0.184	0.076	0.000
5.Balance	(m3/sec)		0.014	-0.007	0.007	0.097	0.297	0.490	0.539	0.676	0.526	0.306	0.276	0.124
(3) Hun Model Area														
= Nam Ngat (Category 2)														
1.Runoff	(m3/sec)		0.028	0.024	0.028	0.056	0.127	0.188	0.235	0.287	0.287	0.188	0.146	0.066
Catchment area		47												
2.Maintenance flow	(m3/sec)		0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
1.0 lit/s/km2		47												
3.Available runoff	(m3/sec)		-0.019	-0.024	-0.019	0.009	0.080	0.141	0.188	0.240	0.240	0.141	0.099	0.019
4.Diversion req.	(m3/sec)		0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.073	0.180	0.137	0.057	0.000
5.Balance	(m3/sec)		-0.019	-0.024	-0.019	0.009	0.080	0.141	0.121	0.167	0.060	0.004	0.042	0.019
= Nam Kham (Category 2)														
1.Runoff	(m3/sec)		0.033	0.028	0.033	0.066	0.149	0.220	0.275	0.336	0.336	0.220	0.171	0.077
Catchment area		55												
2.Maintenance flow	(m3/sec)		0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
1.0 lit/s/km2		55												
3.Available runoff	(m3/sec)		-0.022	-0.028	-0.022	0.011	0.094	0.165	0.220	0.281	0.281	0.165	0.116	0.022
4.Diversion req.	(m3/sec)		0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.021	0.051	0.039	0.016	0.000
5.Balance	(m3/sec)		-0.022	-0.028	-0.022	0.011	0.094	0.165	0.201	0.260	0.230	0.126	0.100	0.022

Table FD-7 Principal Feature of the Irrigation and Drainage Development

(1) Xai Model Area			
1. Irrigable Area in Net	:	302 ha	Right area: 194 ha, Left area: 108 ha
2. Diversion Weir	:	1 no.	Concrete fixed type (H= 4.2 m, L= 60 m)
3. Irrigation Canal			
- Main canal	:	6.9 km	Wet mason lining
- Secondary canal	:	12.9 km	
4. Drainage Canal	:	7 km	
(2) Beng Model Area			
1. Irrigable Area in Net	:	270 ha	Right area: 167 ha, Left area: 103 ha
2. Diversion Weir	:	1 no.	Concrete fixed type (H= 1.6 m, L= 40 m)
3. Irrigation Canal			
- Main canal	:	9.3 km	Wet mason lining
- Secondary canal	:	13.9 km	
4. Drainage Canal	:	6.3 km	
5. River Improvement	:	0.9 km	Nam Hao
(3) Hun Model Area			
1. Irrigable Area in Net	:	258 ha	Nam Ngat area, Right: 70ha, Left(1): 74 ha, Left(2):57 ha Nam Kham area, Left: 57 ha
2. Diversion Weir	:	2 nos.	Nam Ngat No.1: Concrete fixed type (H= 1.8 m, L= 22 m) Nam Kham No.1: Concrete fixed type (H= 2.1 m, L= 40 m)
3. Irrigation Canal			
- Main canal	:	5.7 km	Wet mason lining
- Secondary canal	:	13.6 km	
4. Drainage Canal	:	9.2 km	
(4) Total of Model Areas			
1. Irrigable Area in Net	:	830 ha	
2. Diversion Weir	:	4 nos.	
3. Irrigation Canal			
- Main canal	:	21.9 km	
- Secondary canal	:	40.4 km	
4. Drainage Canal	:	22.5 km	
5. River Improvement	:	0.9 km	

Table FD-8 Required Capacity of Reservoir on the Nam Hao

		Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	Days		31	28	31	30	31	30	31	31	30	31	30	31
a)	Diversion water requirement	m3/sec	0.182	0.325	0.337	0.287	0.114	0.000	0.078	0.085	0.211	0.161	0.066	0.000
b)	River flow at weir site	m3/sec	0.083	0.062	0.076	0.166	0.366	0.559	0.697	0.842	0.835	0.559	0.421	0.193
c)	River flow at dam site	m3/sec	0.083	0.062	0.076	0.166	0.366	0.559	0.697	0.842	0.835	0.559	0.421	0.193
d)	Maintenance flow at dam site	m3/sec	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
e)	(b) - (c)	m3/sec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
f)	(a) - (e)	m3/sec	0.182	0.325	0.337	0.287	0.114	0	0.078	0.085	0.211	0.161	0.066	0
g)	(f) - (c) - (d)	m3/sec	0.168	0.332	0.330	0.190	-0.183	-0.490	-0.550	-0.688	-0.555	-0.329	-0.286	-0.124
h)	Required capacity	1,000 m3	450.0	803.2	883.9	492.5	-490.1	-1,270.1	-1,473.1	-1,842.7	-1,438.6	-881.2	-741.3	-332.1
i)	Accumulation	1,000 m3	450.0	1,253.1	2,137.0	**2,629.5**	2,139.4	869.3	0.0	0.0	0.0	0.0	0.0	0.0

Note: Wet season rice : 237 ha in net
Dry season rice : 237 ha in net

Table FD-9 Required Capacity of Reservoir on the Nam Kham

		Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	Days		31	28	31	30	31	30	31	31	30	31	30	31
a)	Diversion water requirement	m3/sec	0.014	0.025	0.026	0.022	0.009	0.000	0.037	0.040	0.099	0.075	0.031	0.000
b)	River flow at weir site	m3/sec	0.033	0.028	0.033	0.066	0.149	0.220	0.275	0.336	0.336	0.220	0.171	0.077
c)	River flow at dam site	m3/sec	0.031	0.026	0.031	0.062	0.140	0.208	0.260	0.317	0.317	0.208	0.161	0.073
d)	Maintenance flow at dam site	m3/sec	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
e)	(b) - (c)	m3/sec	0.002	0.002	0.002	0.004	0.009	0.012	0.015	0.019	0.019	0.012	0.010	0.004
f)	(a) - (e)	m3/sec	0.012	0.023	0.024	0.018	1.91E-17	0	0.022	0.021	0.08	0.063	0.021	0
g)	(f) - (c) - (d)	m3/sec	0.033	0.049	0.045	0.008	-0.088	-0.156	-0.186	-0.244	-0.185	-0.093	-0.088	-0.021
h)	Required capacity	1,000 m3	88.4	118.5	120.5	20.7	-235.7	-404.4	-498.2	-653.5	-479.5	-249.1	-228.1	-56.2
i)	Accumulation	1,000 m3	88.4	206.9	327.5	**348.2**	112.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Wet season rice : 118 ha in net
Dry season rice : 18 ha in net

Table FD-10 List of Irrigation Canals

Canal Name	Length (m)
(1) Xai Model Area	
1. Main Canal	
LMC	2,290
RMC	4,610
Total	6,900
2. Secondary Canal	
RSC-1	960
RSC-2A	580
RSC-2B	840
RSC-3	890
RSC-4	370
RSC-5A	1,220
RSC-5B	160
RSC-6	460
RSC-7	650
RSC-8A	375
RSC-8B	225
RSC-9	675
RSC-10	370
LSC-1	825
LSC-2	1,280
LSC-3	645
LSC-4	675
LSC-5	1,655
Total	12,855

Canal Name	Length (m)
(2) Beng Model Area	
1. Main Canal	
LMC	4,055
RMC	5,290
Total	9,345
2. Secondary Canal	
LSC-1	1,205
LSC-2	960
LSC-3	1,385
LSC-4	1,145
LSC-5	540
LSC-6	320
RSC-1	1,245
RSC-2A	1,080
RSC-2B	310
RSC-3A	1,900
RSC-3B	290
RSC-4	570
RSC-5	545
RSC-6	1,255
RSC-7	1,165
Total	13,915

Canal Name	Length (m)
(3) Hun Model Area	
1. Main Canal	
LMC-1	1,880
LMC-2	1,530
LMC-3	635
RMC	1,645
Total	5,690
2. Secondary Canal	
LSC-11	695
LSC-12	680
LSC-13	400
LSC-14	495
LSC-15	810
LSC-21	500
LSC-22	665
LSC-23	690
LSC-24A	930
LSC-24B	290
LSC-31	1,085
LSC-32	1,065
LSC-33	970
RSC-1	575
RSC-2A	860
RSC-2B	260
RSC-3	855
RSC-4	1,735
Total	13,560

Table FD-11(1/2) List of Related Structures to Irrigation Canals

Name of Structure	Main Canal					Secondary Canal	Grand Total	Main Canal					Secondary Canal	Grand Total
	Canal Type				Total			Canal Type				Total		
	I	II	III	IV				I	II	III	IV			
	(1) Xai Model Area							**(2) Beng Model Area**						
1. Settling Basin	0	1	1	0	2	-	2	0	1	0	0	1	-	1
2. Spillway	0	1	2	1	4	-	4	0	1	0	2	3	-	3
3. Bifurcation	0	0	0	0	0	-	0	0	1	0	0	1	-	1
4. Turnout	0	2	3	6	11	-	11	0	0	2	9	11	-	11
5. Tail Structure	0	0	0	2	2	-	2	0	0	0	0	0	-	0
6. Check	0	1	2	2	5	-	5	0	0	1	7	8	-	8
7. Check cum Drop	0	0	1	3	4	-	4	0	0	1	0	1	-	1
H = 0.3 - 0.7 m	0	0	0	0	0	-	0	0	0	0	0	0	-	0
H = 0.8 - 1.2 m	0	0	1	3	4	-	4	0	0	1	0	1	-	1
H = 1.2 - 1.5 m	0	0	0	0	0	-	0	0	0	0	0	0	-	0
8. Culvert	0	2	4	1	7	4	11	0	0	2	4	6	4	10
9. Cross Drain	0	1	6	2	9	2	11	0	0	1	5	6	5	11
10. Aqueduct	0	0	0	0	0	1	1	0	0	1	4	5	1	6
11. Division Box	-	-	-	-	-	79	79	-	-	-	-	0	70	70
12. Drop	0	0	0	5	5	20	25	0	0	9	9	18	22	40
H = 0.3 - 0.7 m	0	0	0	0	0	10	10	0	0	0	0	0	5	5
H = 0.8 - 1.2 m	0	0	0	5	5	10	15	0	0	7	0	7	17	24
H = 1.2 - 1.5 m	0	0	0	0	0	0	0	0	0	2	9	11	0	11

Table FD-11(2/2) List of Related Structures to Irrigation Canals

Name of Structure	Name of Structure	Main Canal Type I	Main Canal Type II	Main Canal Type III	Main Canal Type IV	Main Canal Total	Secondary Canal	Grand Total
(3) Hun Model Area								
1. Settling Basin	1. Settling Basin	0	0	0	4	4	-	4
2. Spillway	2. Spillway	0	0	0	4	4	-	4
3. Bifurcation	3. Bifurcation	0	0	0	0	0	-	0
4. Turnout	4. Turnout	0	0	0	8	8	-	8
5. Tail Structure	5. Tail Structure	0	0	0	4	4	-	4
6. Check	6. Check	0	0	0	5	5	-	5
7. Check cum Drop	7. Check cum Drop	0	0	0	3	3	-	3
H = 0.3 - 0.7 m	H = 0.3 - 0.7 m	0	0	0	0	0	-	0
H = 0.8 - 1.2 m	H = 0.8 - 1.2 m	0	0	0	1	1	-	1
H = 1.2 - 1.5 m	H = 1.2 - 1.5 m	0	0	0	2	2	-	2
8. Culvert	8. Culvert	0	0	0	3	3	7	10
9. Cross Drain	9. Cross Drain	0	0	0	3	3	6	9
10. Aqueduct	10. Aqueduct	0	0	0	0	0	1	1
11. Division Box	11. Division Box	-	-	-	-	0	66	66
12. Drop	12. Drop	0	0	0	7	7	43	50
H = 0.3 - 0.7 m	H = 0.3 - 0.7 m	0	0	0	1	1	19	20
H = 0.8 - 1.2 m	H = 0.8 - 1.2 m	0	0	0	5	5	24	29
H = 1.2 - 1.5 m	H = 1.2 - 1.5 m	0	0	0	1	1	0	1

Table FD-12 List of Drainage Canals

Canal Name	Length (m)	Canal Name	Length (m)	Canal Name	Length (m)
(1) Xai Model Area		**(2) Beng Model Area**		**(3) Hun Model Area**	
A-1	1,000	C-1	600	B-1	1,285
A-2	745	C-2	575	B-2	1,025
A-3	860	C-3	1,215	B-3	1,660
A-4	825	C-4	1,930	B-4	400
A-5	1,010	C-5	1,300	B-5	595
A-6	300	C-6	725	B-6	400
A-7	710			B-7	2,245
A-8	1,000	Total	6,345	B-8	500
A-9	550			B-9	1,050
Total	7,000			Total	9,160

Table FD-13 List of Related Structures to Drainage Canals

Name of Structure	Canal Type				Total
	Type I	Type II	Type III	Type IV	
(1) Xai Model Area					
1. Culvert	1	1	1	0	3
2. Drop	10	4	7	8	29
H = 0.4 - 0.6 m	4	0	1	0	5
H = 0.7 - 1.2 m	6	4	6	4	20
H = 1.3 - 1.5 m	0	0	0	4	4
3. Junction					3
(2) Beng Model Area					
1. Culvert	2	0	1	0	3
2. Drop	6	6	5	0	17
H = 0.4 - 0.6 m	4	0	0	0	4
H = 0.7 - 1.2 m	2	5	5	0	12
H = 1.3 - 1.5 m	0	1	0	0	1
3. Junction					2
(3) Hun Model Area					
1. Culvert	1	1	0	0	2
2. Drop	33	8	10	0	51
H = 0.4 - 0.6 m	8	3	1	0	12
H = 0.7 - 1.2 m	25	5	0	0	30
H = 1.3 - 1.5 m	0	0	9	0	9
3. Junction					2

Figure

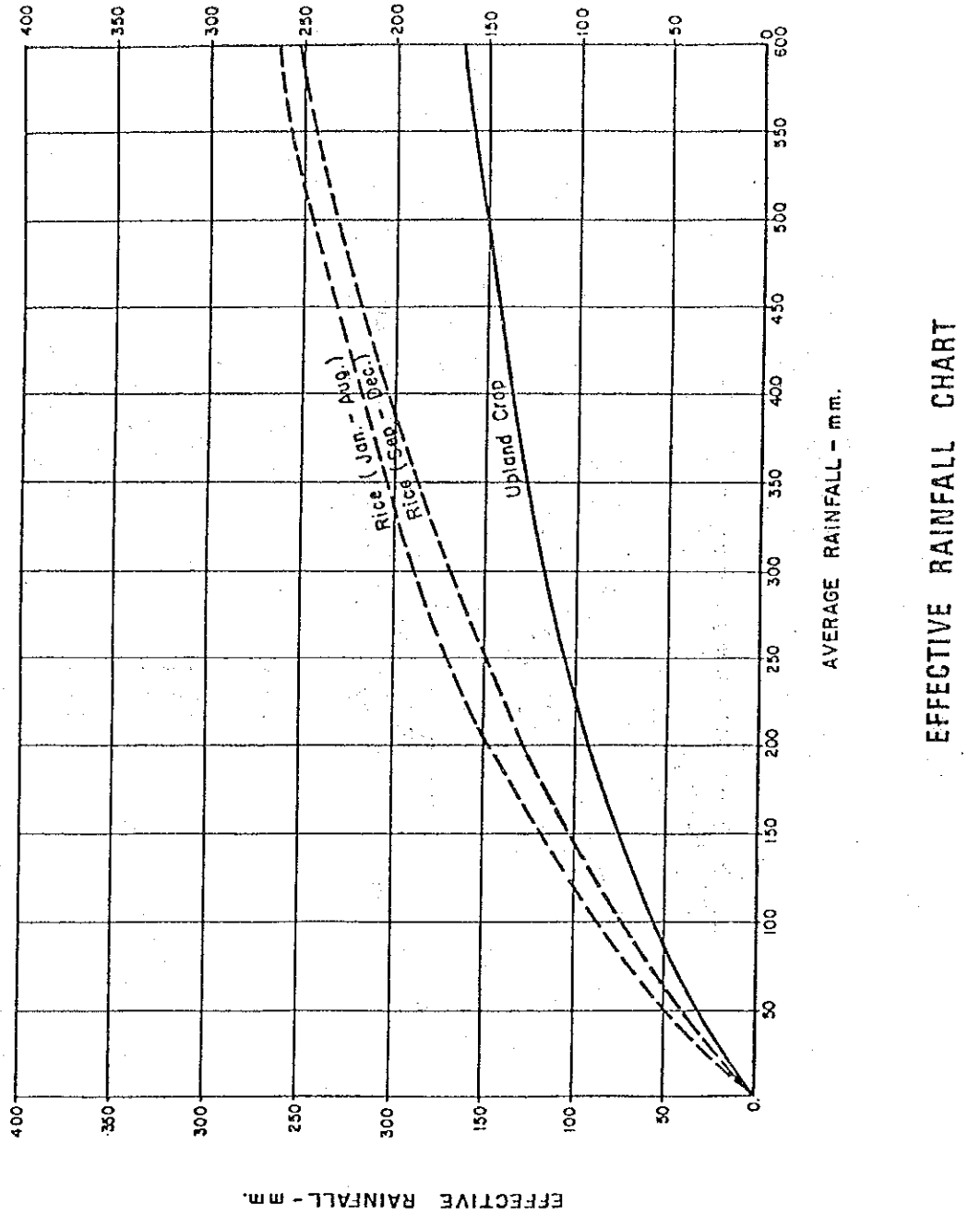

Fig. FD-1 Effective Rainfall

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
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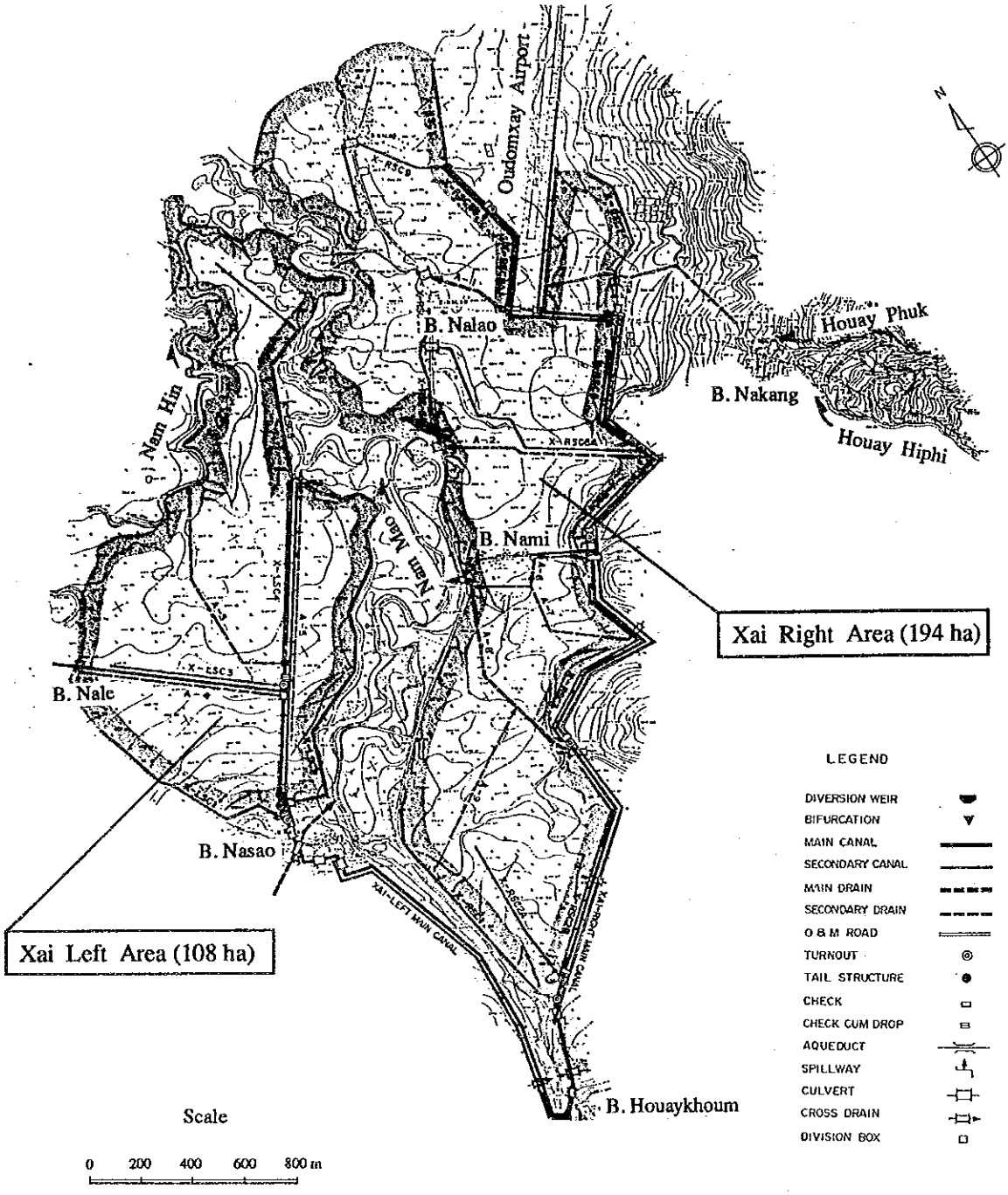

Fig. FD-2 Irrigation Development Plan of Xai Model Area

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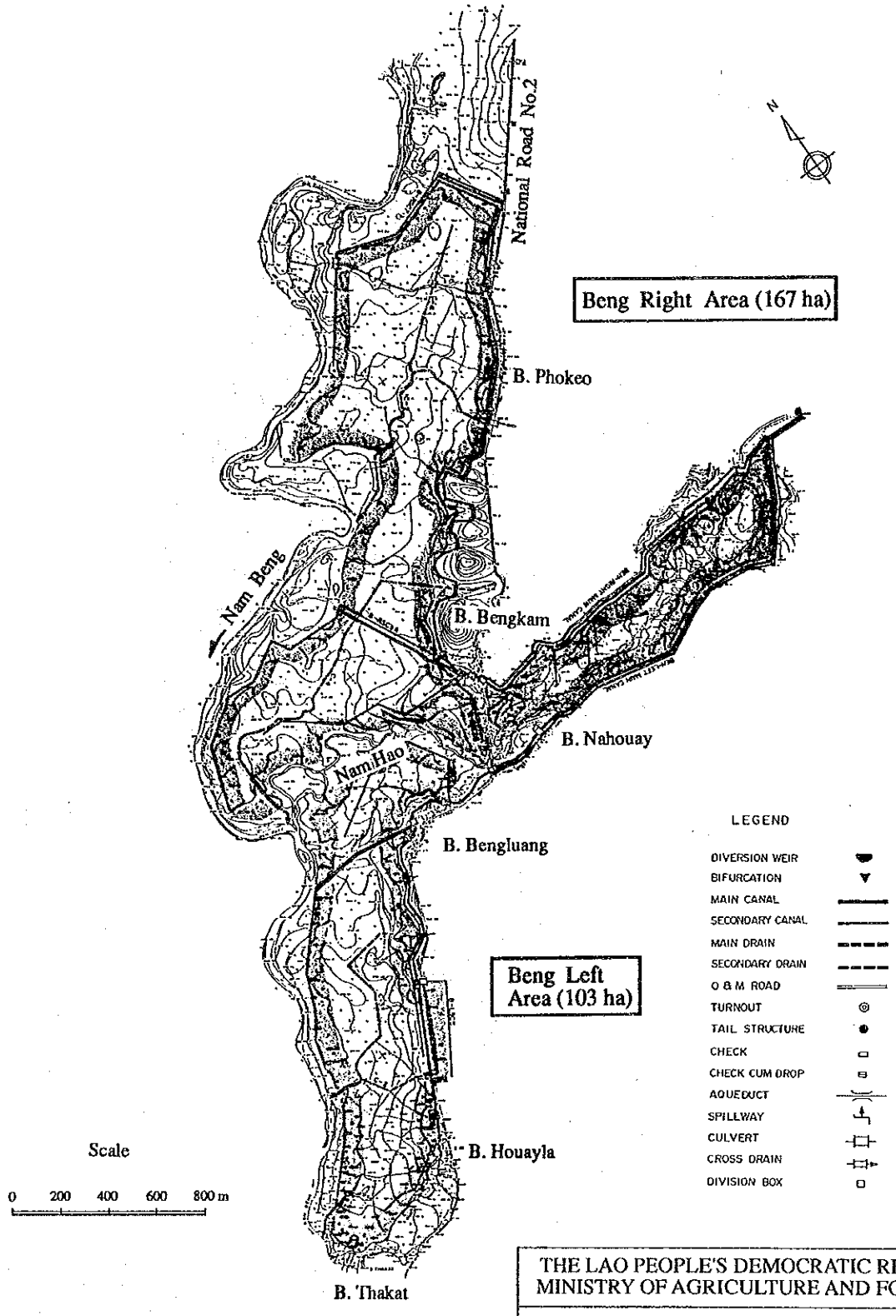

Fig. FD-3 Irrigation Development Plan of Beng Model Area

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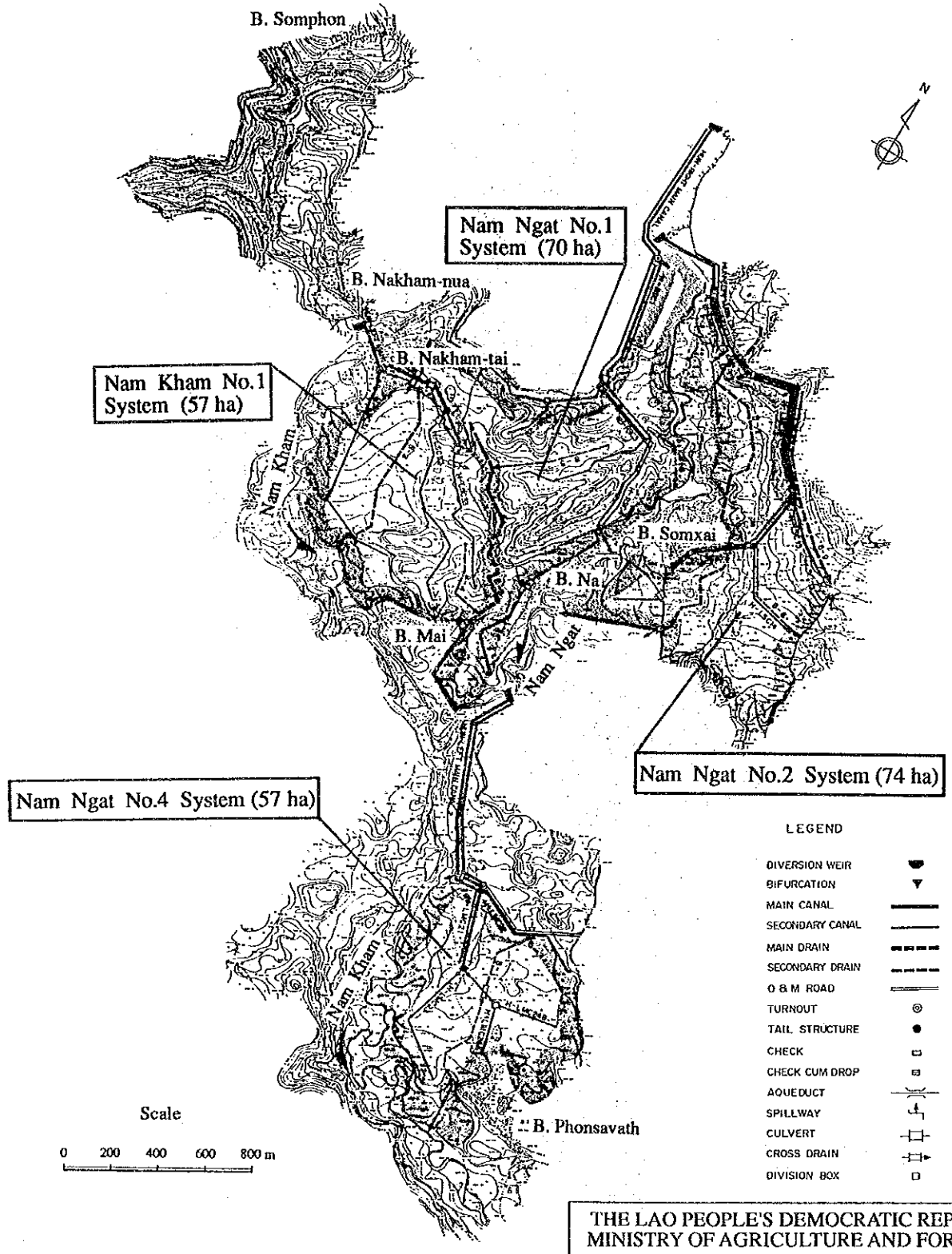

Fig. FD-4 Irrigation Development Plan of Hun Model Area

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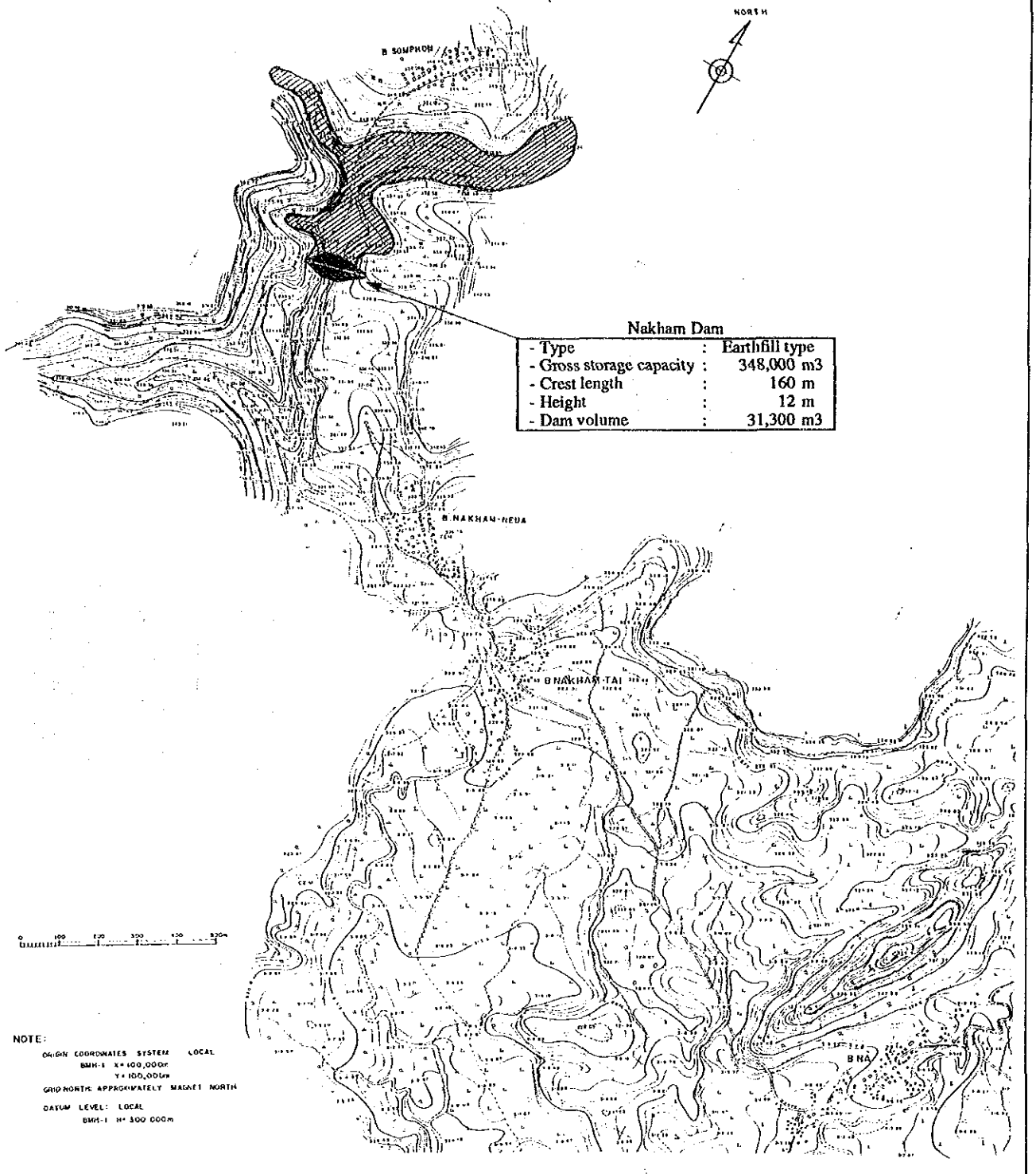

Fig. FD-5 Nakham Dam Plan of Hun Model Area

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
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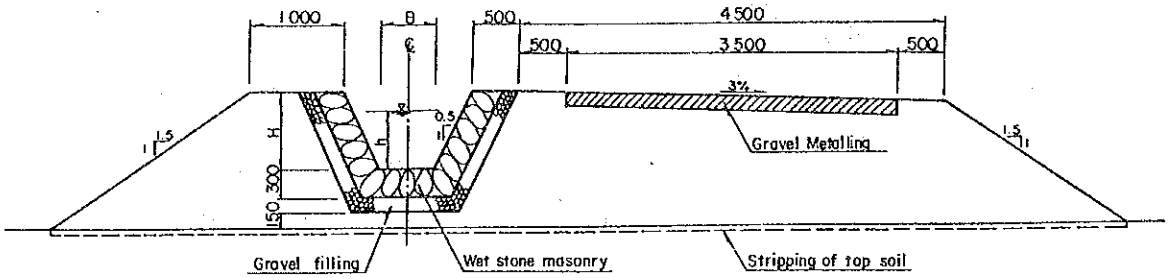
IRRIGATION CANAL

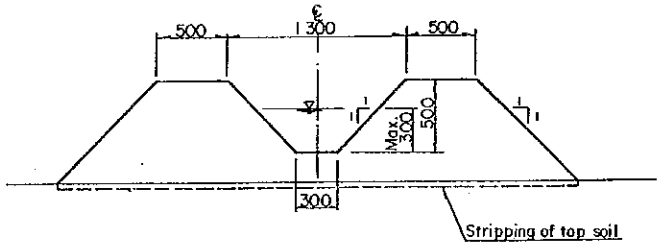
MAIN IRRIGATION CANAL

WET STONE MASONRY-LINED CANAL O & M ROAD



SECONDARY IRRIGATION CANAL

UNLINED CANAL

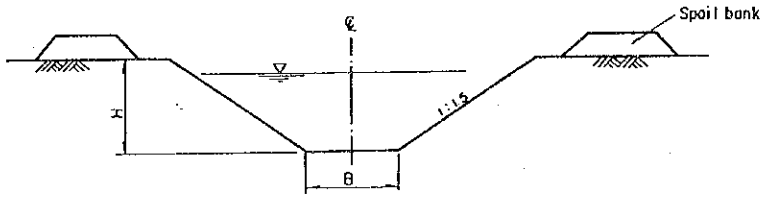


DIMENSION OF IRRIGATION CANAL

(Unit : mm)

Canal Type	B	H	h (max)
I	700	900	700
II	600	800	600
III	500	700	500
IV	400	600	400
V	300	500	300

DRAINAGE CANAL



DIMENSION OF DRAINAGE CANAL

(Unit : mm)

Canal Type	B	H
I	500	600
II	1,000	1,000
III	1,500	1,200
IV	2,000	1,500

Fig. FE-6 Typical Cross Sections

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
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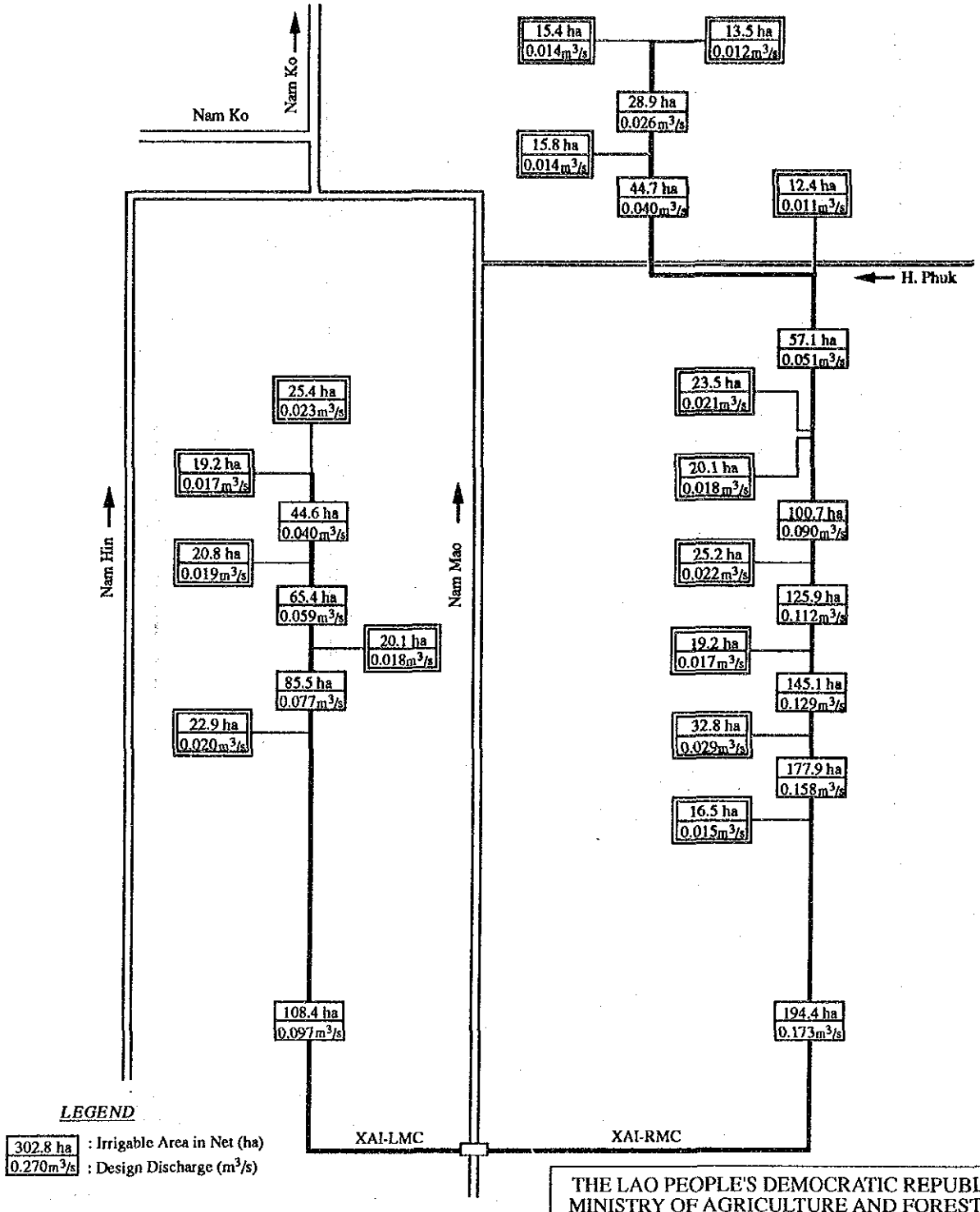

Fig. FD-7 Irrigation Flow Diagram of Xai Model Area

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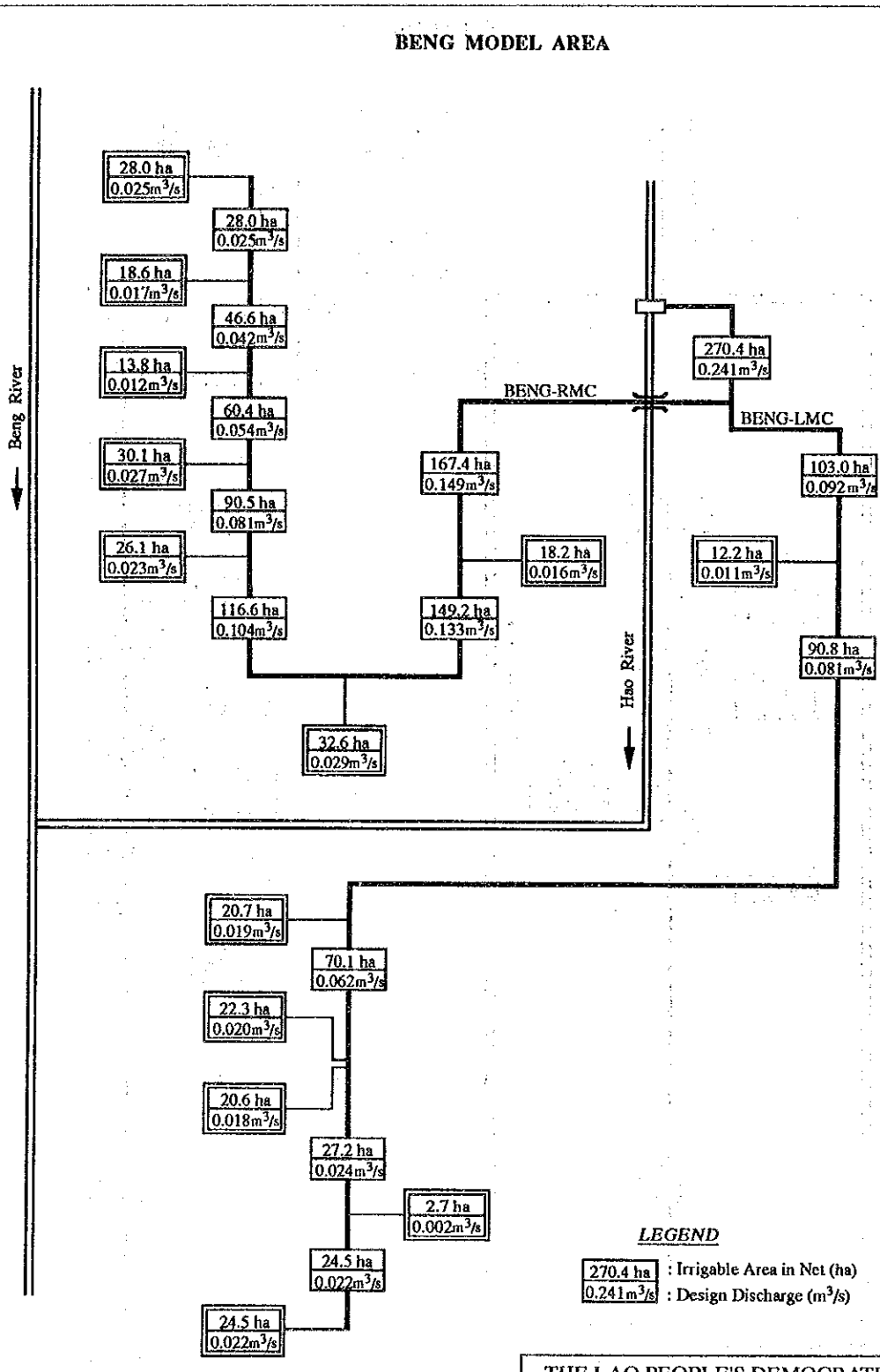

Fig. FD-8 Irrigation Flow Diagram of Beng Model Area

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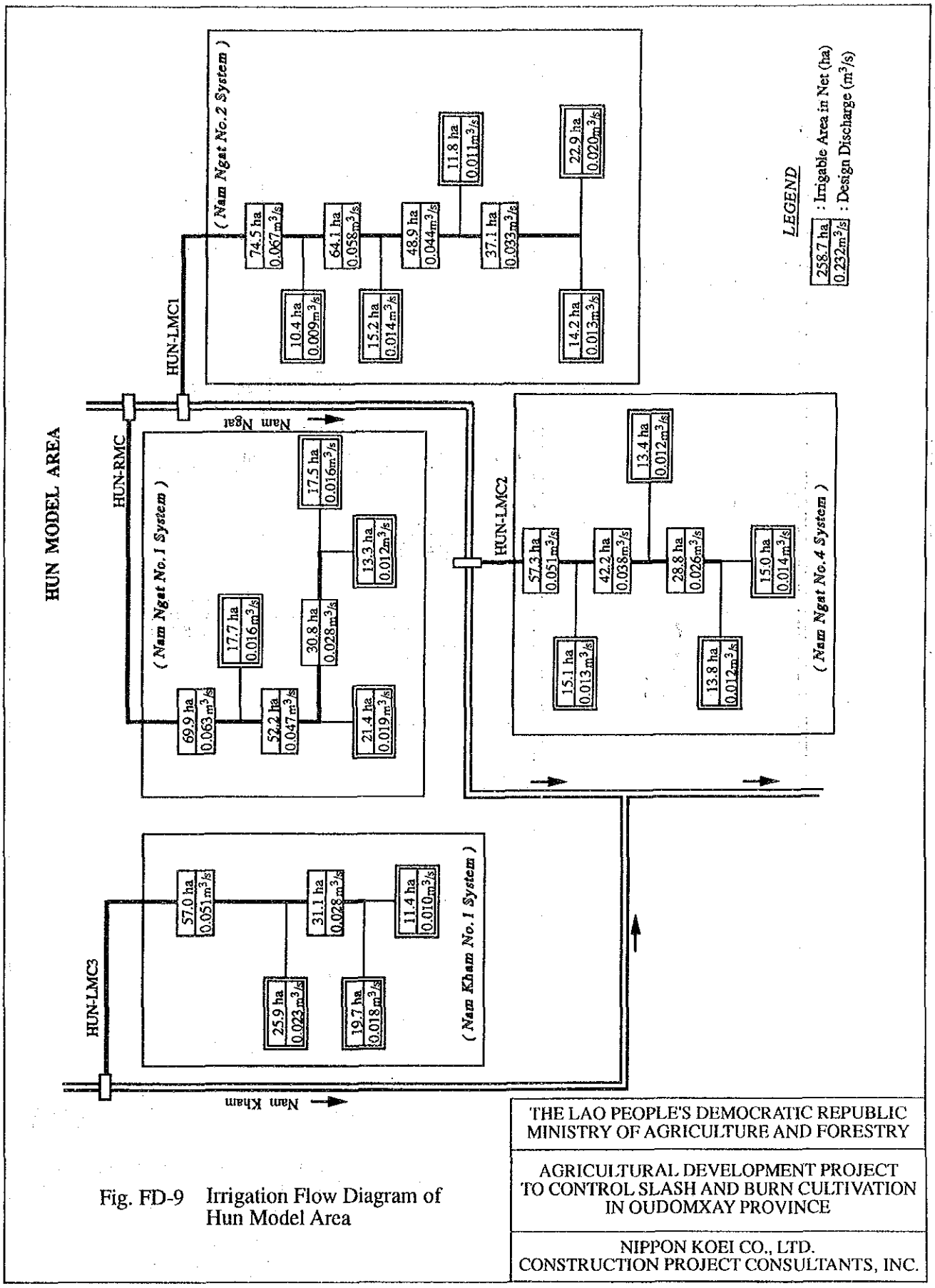

Fig. FD-9 Irrigation Flow Diagram of Hun Model Area

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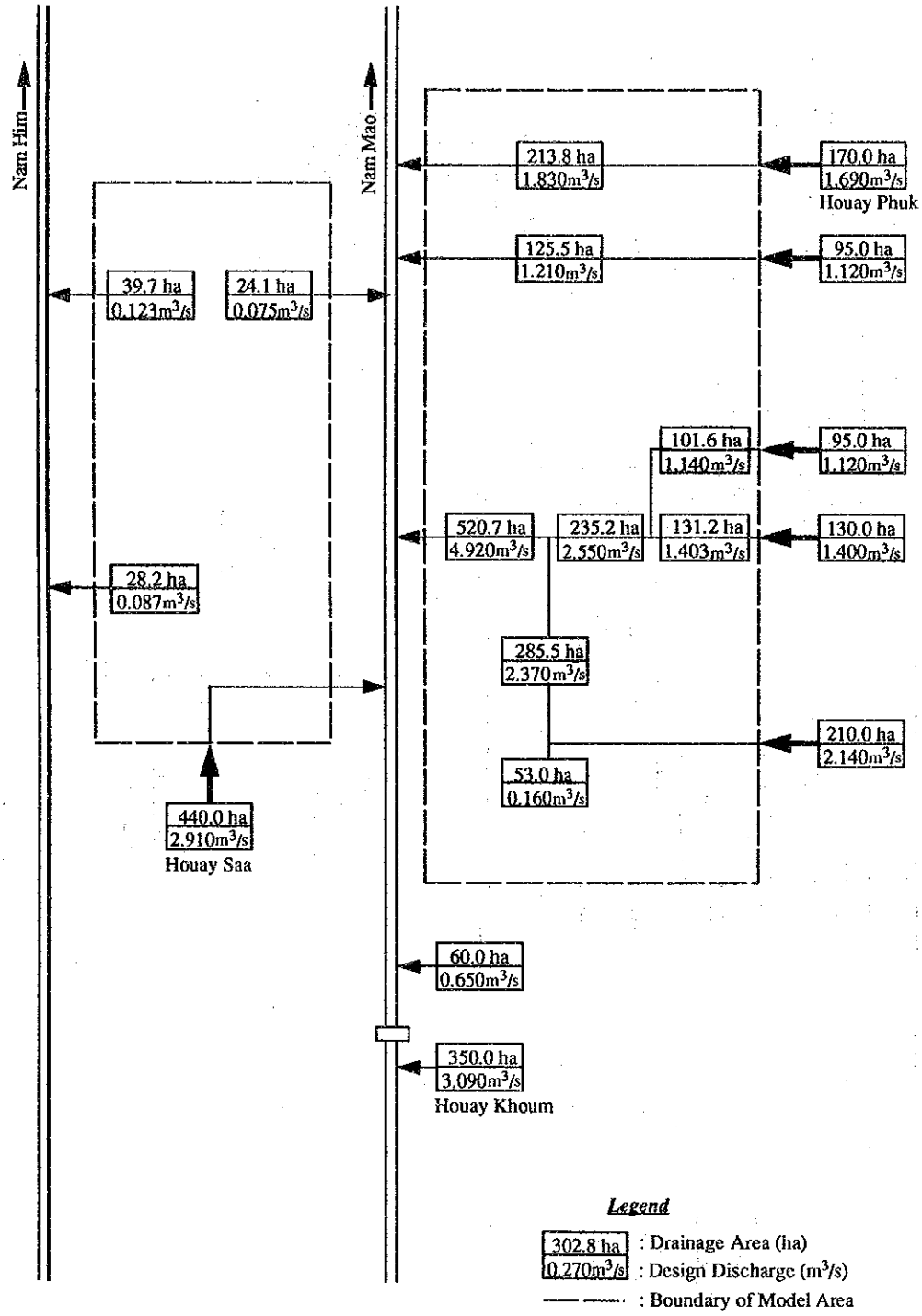

Fig. FD-10 Drainage Flow Diagram of Xai Model Area

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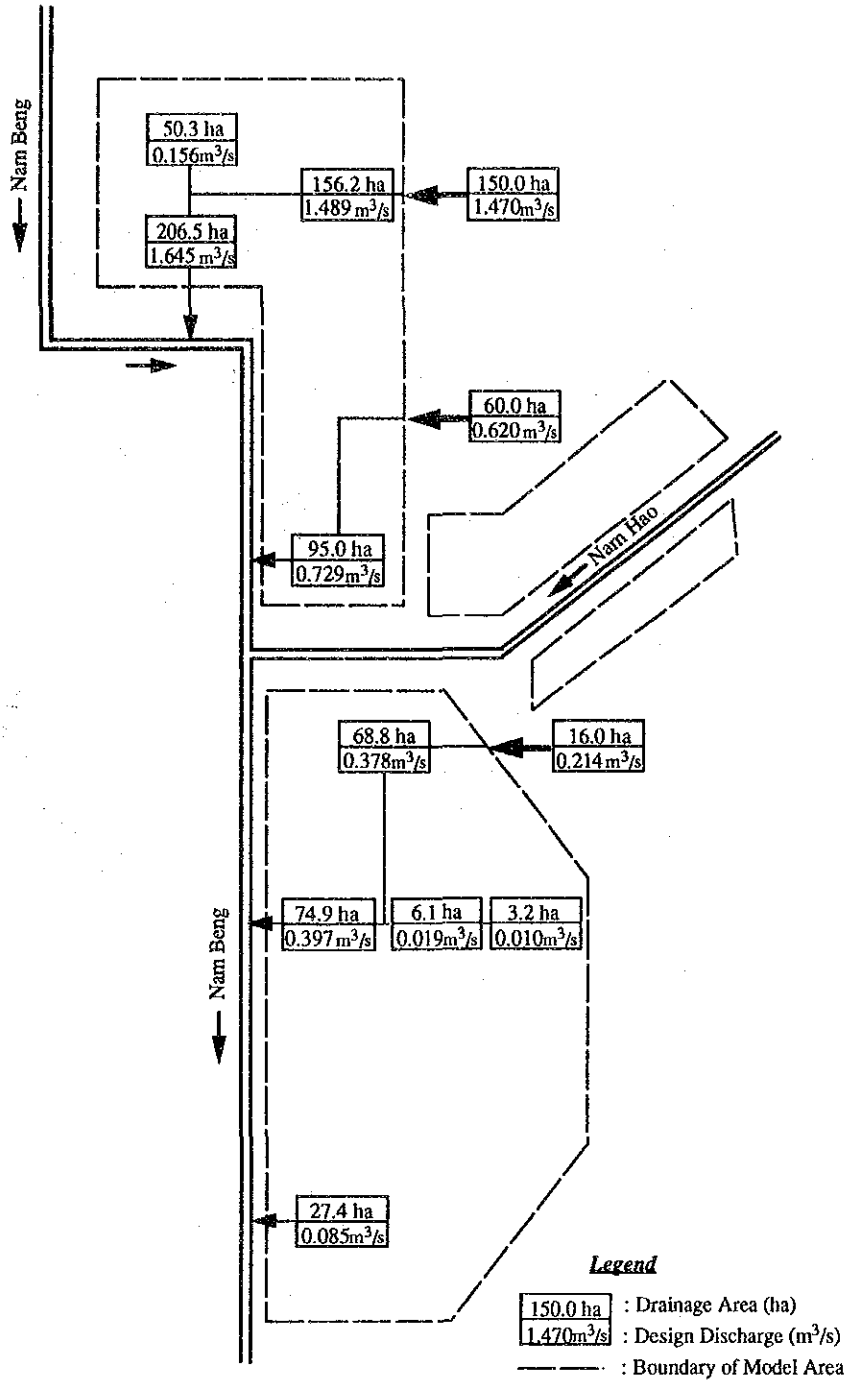

Fig. FD-11 Drainage Flow Diagram of Beng Model Area

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
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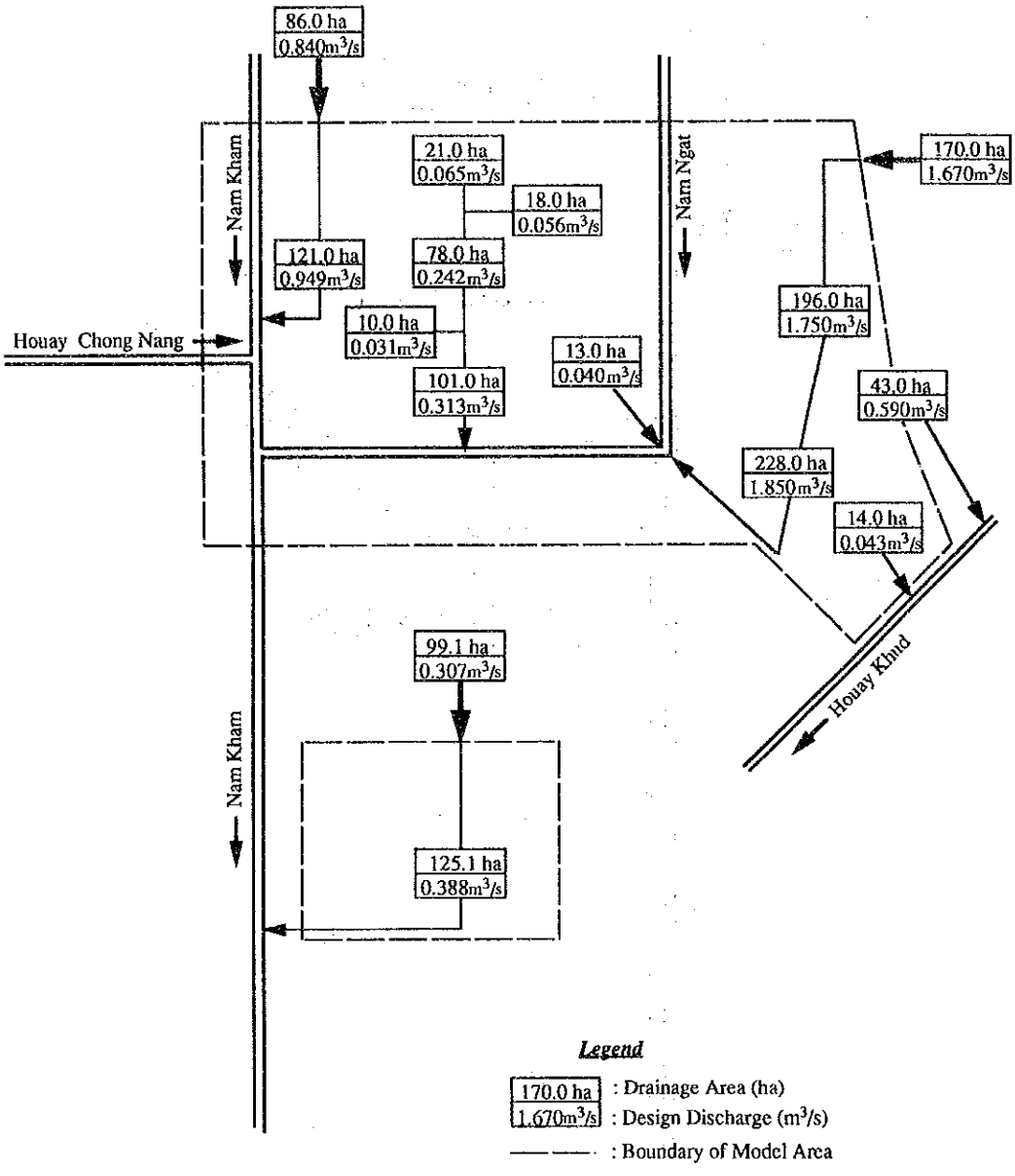

Fig. FD-12 Drainage Flow Diagram of Hun Model Area

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
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ANNEX-FE
SOCIAL INFRASTRUCTURES

ANNEX-FE SOCIAL INFRASTRUCTURES

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LIST OF TABLES

LIST OF FIGURES

1. GENERAL

This ANNEX presents the results of the studies on the development and rehabilitation of social infrastructures in connection with the agricultural development in the model areas. Among various items of social infrastructures, priority will be given to the development of the following items which will support directly and indirectly the successful implementation of the model areas development as well as to accelerate the socio-economic activities of the people in rural area:

(a) District road network
(b) Rural water supply system
(c) Rural electiricity supply facility
(d) Primary school and community house

2. DISTRICT ROAD NETWORK

2.1 Present Condition

There are two district roads related to the model areas. One is in Xai model area, which connects Nasao and Nale villages to the National Road No.2 with a total length of about 1.9 km, and the other runs from Hun town to Somphon village with a total length of 7.5 km in Hun model area. The former extends further to Kavang, Tangkok and Chomong, connecting five sub-districts to the Road No.2. The latter also connects three sub-districts to Hun town through Kang and Phouthong villages in the remote area.

In spite of the fact that these roads play an important role in connecting the remote areas with the district centres for the people's socio-economic activities, the road conditions are very poor, passable only in the dry season by 4-WD vehicles or trucks because of the lack of drainage facilities. The district office is responsible for maintenance of these roads which includes repair of wooden culverts, drains and grass cutting. However, such a maintenance is still not sufficient, because it usually depends on the farmers' cooperation after the harvest season.

2.2 Development Plan

It is proposed that two district roads in Xai and Hun model areas be rehabilitated as a model in improving the district road network in the future, taking into account the function of these district roads. The proposed roads will be of all-weather type paved by gravel with appropriate number of drainage facilities and three (3) causeways on the Nam Mao, Nam Ngat and Nam Kham rivers respectively. The development plan of these roads is summarized as follows :

Item	Unit	Xai Model Area (H. Khoum to Nale)	Hun Model Area (Hun to Somphon)
Road Length	km	1.9	7.5
Causeway	Nos.	1	2
Cross Drain			
- Pipe Culvert	Nos.	4	28
- Box Culvert	Nos.	3	5

Because periodic maintenance is indispensable to maintain the roads in good condition throughout the year, the existing maintenance organization of the districts will also be strengthened with a cooperation of the farmers. The location of the proposed district roads for rehabilitation is shown in Fig. FE-1.

3. RURAL WATER SUPPLY SYSTEM

3.1 Present Condition

3.1.1 Existing Rural Water Supply System

There exist two gravity flow piped water supply systems in and around the Beng and Hun model areas. The system in Beng town constructed in 1992 with financial assistance from Lao Quaker serves five villages, all of which are related to Beng model area. The system in Hun town, which was constructed in 1989 with an assistance by UNICEF, covers six villages, of which only one village is relevant to Hun model area.

The Beng town water supply system has 26 stand taps to supply water to 362 families with a total population of 1,892. This means that one tap can serve 14 families on an average. Although the system is well-maintained, a problem is low water quality due to contamination resulting from no filter, because there is one village in the upstream of the water source. Therefore, the villagers never use the water from the system directly for drinking but for bathing and washing purposes. One district officer of the public health section and two villagers (temporarily employed by the district) are responsible for maintenance of this system, making periodic patrol once a week to check sediment in the pipes, especially in the rainy season. For this maintenance work, Kip 70/family/month are collected as water charge by the district.

The Hun system is supplying domestic water to 638 families with a total population of 3,794, using 40 stand taps, 16 families per tap. Because of limited availability of water source, the system can not supply enough water to villages located in elevated land. At the time of construction, the district office collected Kip 13,000 per tap for maintenance of the system, and no water charge has been collected since then. The maintenance of the system is carried out by three technicians of the district office, using the above money collected at the time of construction. It is planned to collect new water charge from 1993 for continuous maintenance. The office estimates that the water charge will vary from Kip 1,000 to 4,000/tap/month based on actual water consumption at each tap in the past. In order to collect proper water charge, the office considers that measuring device should be installed at each tap in the future.

3.1.2 Water Supply System in Model Area

Out of 22 villages relevant to the model areas, the people in eight villages can use domestic water from the urban water supply system in Xai city and rural water supply systems in Beng and Hun district centers, though there are some problems such as insufficient discharge and low water quality.

Usually, the people in the remaining villages are doing washing and bathing in the streams nearby the villages. As for the drinking water, almost all the villages depend on only one or two shallow wells or dug holes beside the streams. Some of these wells and holes are maintained properly and protected from water contamination using concrete rings, but some have the contamination problem especially in the rainy season. In addition, some villages are using water even from the irrigation canals. During the late dry season, April to June, the villagers have to fetch water directly from the streams even for drinking purpose, because the wells dry up. Women, young girls, children and old-age people are generally responsible for fetching water for drinking and washing purposes.

The present water supply facilities being used by the villagers in and around the model areas are summarized in Table FE-1.

3.2 Development Plan

On the basis of field survey results, three rural water supply schemes, one in each district, will be included in the model areas development scheme, taking into consideration the availability of water sources, population of beneficiary and urgency of supplying clean water in 12 villages in and around the model areas. These villages are located three in Xai model area, four around Beng model area and five in Hun area, respectively, as shown below:

Model Scheme	Nos. of Village	Village
Xai	3	Nasao, Nale, Houay Khoum
Beng	4	Phokeo, Pangdua, Nalai, Gnjo
Hun	5	Somphon, Nakham-nua, Nakham-tai, Na Mai

The proposed water sources are available in Houay Khoum river with 6.7 lit/sec of discharge for Xai scheme, Houay Lai river with 2.9 lit/sec for Beng scheme and in Houay Phon river with 5.7 lit./sec of water for Hun scheme respectively, which were observed in early November 1992. These sources are investigated and determined to be suitable for water supply system in terms of their water quality and quantity, and will not give any affect on the existing irrigation water supply.

The organization of operation and maintenance for the proposed water supply systems will be indispensable and be established under the district offices with farmers' cooperation including a collection of proper water charge for continuous maintenance.

The proposed plan of the water supply schemes is summarized in Table FE-2, and location of the schemes is shown in Fig. FE-2.

4. RURAL ELECTRIC SUPPLY

4.1 Present Condition

There is only one micro-hydropower plant for rural electricity supply in Beng town. The plant was completed in June 1992 with an economic assistance by the People's Republic of China. The total construction cost was Kip 14 million (US$20,000 equivalent), which consisted of 80% foreign currency portion and 20% of local portion. The foreign portion was shared by the government of China (to be granted) and the Oudomxay province, and the local portion was born by the beneficiaries in a form of materials such as rock, gravel and log, and man power contribution.

The main features of the plant are as follows :

- Generating capacity	:	3 kW x 2 units
- Water source	:	Nam Hao river
- Effective head	:	3.8 m
- Distribution line	:	2.6 km
- Beneficial village	:	Three villages
- Number of lamp	:	235 (20 - 40 W)

After the completion, the plant was operated three times in September when excess water was available from the irrigation system because of heavy rain, and continuous operation was started from early November 1992. Three staff of the industry section of the district office are responsible for operation of the plant.

Even though the continuous operation can be made during the non-irrigation period, the flow in the canal is not enough to operate the two units fully. The one unit is being operated for two hours every two days, supplying the electricity alternately to 117 lamps in one village and 118 lamps in other two villages. Actual generation was 1.7 kW per unit in November. Whenever excess water is available during the daytime, the water is discharged through the plant not for lighting but for radiating heat.

The problems currently encountered are summarized as follows :

- The priority of water supply is given to irrigation purpose.
- Because of low technology in water management of the irrigation system, it is difficult to determine timely when excess water is available for generating purpose.
- Because of traditional brushwood weir and water requirement for domestic use by the people, the amount of water diverted from the river will not be enough for full operation of the plant during the dry season.
- The Nam Hao irrigation system currently serves six villages. On the other hand, the power plant can supply electricity to three villages of the six. In order to operate both the system and the plant properly, balance of the benefit from the same water source should be taken into consideration among the people concerned.
- At present, the electricity charge is set at Kip 600 per 20-W lamp per month. However, no charge has been collected because of unsatisfactory operation of the plant.

4.2 Proposal for Medium Term Development Program

4.2.1 Improvement of Operation System of Existing Facilities

As mentioned above, a micro-hydropower plant is constructed in Beng town and the operation is just started. However, the operation is very limited and complicated, because the water being used for power generation is originally for irrigation purpose and domestic use by the people. It is therefore proposed to examine and improve the present O & M system of this power plant in connection with the implementation of the Beng irrigation system to be rehabilitated under the short term development program of the Project. Such examination and improvement will provide data and information useful for planning the future micro-hydropower development in other areas where the potential exists. In addition, the existing water management organization for the Nam Hao irrigation system should be strengthened in order to operate both systems properly with the balanced water allocation program. Even in this case, however, the first priority should be given to the irrigation purpose as it is.

4.2.2 Potential Site for Future Hydropower Development

The field survey shows that there is a suitable site on the Nam Hao river for micro-hydropower development which may be included in the medium term development program of the Master Plan. The site is located at about 8 km upstream from the National Road No.2, and forms a narrow gorge between rocky hills with 20 m of width to construct a small-scale dam with an effective head of 5 to 6 m. It is expected to generate five to ten kW of electric power throughout the year at this site. The preliminary design of this micro-power generation scheme is summarized in the Master Plan Report.

5. PRIMARY SCHOOL AND COMMUNITY HOUSE

5.1 Present Condition

5.1.1 Primary School

Most of the primary schools in the villages have Class I and II, and Thaohom schools (primary schools belonging to town or sub-district) have generally Class III to V, covering several villages nearby.

There exist 17 primary schools in the villages and four Thaohom schools in and around the model areas. Because of the limited education budget of the province, most of the primary schools in the villages are established and maintained by the villagers responsibility, except for some schools such as Thaohom ones which are managed by the province.

The conditions of school house are very poor. Most of them consist of thatched roof, bamboo mat wall and earth floor with humble lumber of desks, chairs and blackboards. Out of 17 villages related to the model areas, nine villages have no school house and utilize the village community house, village office or sub-district clinic. The floor space and number of class room in these facilities are not sufficient for the pupil, with an average space of about 30 to 40 m^2, 7 m in length and 5 m in width. The pupil of Class I and II are studying together in one room with a teacher. The number and level of teachers are also not sufficient. Most of them in the village schools are Komoun (non-certified, graduated from the primary school or secondary one), and some villages have difficulty in finding even such teachers.

5.1.2 Village Community House

The community house in each village is presently utilized for the following purposes :

- Announcement of information from the province and district
- Meeting for arrangement of festivals, traditional events, etc.
- Meeting for public cooperative works such as maintenance of irrigation facilities, roads, schools, etc.
- Meeting for evaluation and collection of tax
- Settlement of the matters among the villagers

The frequency of using the village community house varies, depending on the season and villages. The survey result shows that it is two to three times a month on an average. In spite of the fact that such a community house is useful for various activities by the villagers, the conditions of the house are poor and not well-maintained. Among the villages in and around the model areas, five villages do not have the house for their exclusive use, and utilize the primary school whenever necessary, making a temporary holiday for the pupil.

The floor space of the house varies with the population of each village. The average size is about 80 to 120 m^2 in floor space, 14 m in length and 7 m in width. The house is constructed generally with galvanized iron sheet and bamboo mat wall on the earth floor. Because of no furniture in the house, the villagers are requested to bring their chairs at the meeting time.

The present situation of the primary schools and community houses in and around the model areas is shown in Table FE-3.

5.2 Development Plan

As discussed above, rehabilitation and new construction of primary schools and village community houses will be required in connection with the integrated rural agricultural development in the model areas. However, it is proposed that the first priority should be given to the rehabilitation of primary schools, taking into account the more importance of children's education, its urgency and farmers' intention. In addition, the rehabilitated school building could be used also for the activities of the village community.

The proposed rehabilitation plan of the primary schools is made based on the discussion with the staff concerned of the province and district offices as well as the village leaders. The basic concept of the plan is as follows:

- A high priority will be given to the rehabilitation of Thaohom school, and the village primary schools located nearby will be integrated into the rehabilitated Thaohom school.

- Primary schools in the villages will be integrated into one to construct a new school between two villages, if the two villages locate within a short distance.

As a result, it is proposed to construct four (4) Thaohom schools and eight (8) primary schools in total, five schools in Xai, three in Beng and four in Hun, respectively, as shown below :

Model Area	Nos. of School	Nos. of Village	Village
Xai	5	5	Nalao, Nasao, H. Khoum, Cheng, Nale
Beng	3	3	Phokeo, Thakat, Benglouang
Hun	4	6	Somphon, Nakham-nua, Nakham-tai, Na, Mai, Somxai

The rehabilitation plan of the primary schools related to each model area is summarized in Table FE-3 and the location is shown in Fig. FE-3.